INVENTION AND DISCOVERY.

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ARKWRIGHT'S WIFE DESTROYING THE MODELS.

INVENTION & DISCOVERY

BY
RALPH AND CHANDOS TEMPLE.

"Keep unshak'd
That temple, thy fair mind."
SHAKSPERE.

Illustrated.

LONDON:
GROOMBRIDGE & SONS,
PATERNOSTER ROW.

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THE TEMPLE ANECDOTES.

INVENTION AND DISCOVERY.

THE TRUE MOTHER OF INVENTION.

More than twelve hundred patents have been granted since the beginning of the present century for new machines and improvements in machinery used in the cotton manufactures alone. When we glance at the list and find it teeming with well-known Lancashire names, we perceive at once that here, as in all other branches of industry, necessity was the mother of all this world of invention—the necessity of the manufacturer, who daily and hourly felt the want of the improvements there enumerated. It has been, in fact, in the fruitful soil of our great cotton manufactures that all these devices for saving human labour and conferring abundance upon mankind, have sprung up. But for the extensive cotton manufacture, very early established in Lancashire, it may safely be assumed that the idea of the spinning jenny could not have occurred to Hargreaves; nor that of the spinning frame to Paul or Arkwright; nor that of the mule to Crompton; nor would the numerous inventions that have arisen

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from these in all probability have existed, or, if at all, not in their present form. The causes which led to the establishment of this kind of industry in Lancashire were the true parent of these inventions. It is interesting, therefore, to find that all this prosperity seems to have sprung from the remarkable liberality of the Lancashire people at a period when jealousy, distrust, and seclusion were the ruling motives of nearly every branch of trade, international and domestic. More than two centuries ago the Warden and Fellows of Manchester College, in order to encourage ingenious strangers to settle in their town, granted them the benefit of the adjacent woods to cut timber for constructing their looms, at the annual charge of only fourpence each; and in this they were no doubt carrying out only a traditional policy; for the Manchester spinners and weavers were already famous. Dr. Ure remarks that these "Marts of Industry" were completely the offspring of Nature; but it is certain that they are due to these moral causes in a far greater degree than to any peculiar natural advantages; for not even the coal and iron of these districts can explain their prosperity, which had reached a considerable degree of development before steam power, or even machines, were in use.

ARKWRIGHT'S WIFE DESTROYING THE MODELS.

It is well known that Sir Richard Arkwright—to whose ingenuity and perseverance, more than to any other cause, we are indebted for the marvellous growth of our cotton manufactures—began life as a poor barber. It is now more than a hundred years since he occupied a kind of underground kitchen in the town of Bolton, in Lancashire, to which he endeavoured to attract customers by exhibiting a board with the facetious inscription, "Come to the Subterranean Barber: he shaves for a Penny." Whether the barbers of the town really dreaded this announcement, or merely felt the customary jealousy towards an interloper—for Arkwright was a native, not of Bolton, but of Preston—does not appear; but a fierce opposition is said to have been at once commenced between them. The Bolton barbers reduced their prices; but the man whose inventive genius was destined to create a revolution in British industry was not likely to be beaten when fairly roused. Arkwright took down his board, and painted out the offensive inscription; but it was only to substitute the still more alarming words—"Richard Arkwright, Subterranean Barber; a Clean Shave for a Halfpenny!" We may assume that the Bolton barbers after this left their underground rival to shave the town in peace.

Where Arkwright's cellar was, is not exactly known—indeed, the facts relative to his early life are somewhat obscure; but Mr. French, in his Biography of

Crompton, informs us that a gentleman in Bolton still preserves, as a relic of Arkwright, the leaden vessel in which his customers were accustomed to wash after being shaved. Like most handicraftsmen, whose business leaves them much spare time, barbers are frequently ingenious men—a truth which appears to be as old as the Arabian Nights' Tales; most readers of which will remember the barber who left his half-shaven customers to take astronomical observations in an adjoining garden. Arkwright appears to have corresponded in many ways with that ancient prototype of Oriental humour. His mind was always filled with schemes of ingenious mechanism for shortening labour, and appears, like many other uneducated men, to have long dreamed of discovering that philosopher's stone of mechanics—perpetual motion. Like the wife of the potter, Bernard Palissy, Mrs. Arkwright was not unnaturally impatient of his neglect of the customers, who now began, we may suppose, to be more numerous in the barber's kitchen. Convinced that he would starve his family by scheming when he ought to be shaving, Mrs. Arkwright one day, in a fit of anger, destroyed some of his cherished models of machinery; and in a moment the unfortunate barber saw the fruit of his labour and ingenuity, and all the prospective wealth that they were to bring him, gone, as he thought, for ever. Arkwright never forgave this act. He separated from her immediately, nor would anything induce him ever to live with her again.

HOW ARKWRIGHT CONSTRUCTED HIS FIRST MACHINE.

When Arkwright gave up his subterranean kitchen, and withdrew from competition with the barbers of Bolton, it was only to practise a more profitable branch of their trade. Being in possession of a secret of a chemical process for dyeing human hair, whether of his own discovery is not known, he became an itinerant dealer in that article, which, owing to the universal use of wigs in 1760, was in great demand. The dyeing of hair is still accounted one of the most delicate and difficult of chemical operations, and Arkwright's secret was therefore one from which he no doubt expected great profits. According to Mr. Richardson, a hairdresser in the town of Leigh, and one of Arkwright's customers, his hair was in great esteem, and was considered the best in the country. The wandering barber guarded his secret with a jealousy which afterwards became in him a confirmed habit, and in later years was a prominent feature in his character. Yet Arkwright remained a poor man. In his solitary wanderings from village to village, collecting hair from those who were willing to be shorn, for the benefit of richer wearers of wigs, his mind was still intent upon his favourite idea of constructing new machines. The country through which he travelled was the seat of the cotton manufacture, and the inhabitants of every farmhouse, and the people of every village, were weavers or spinners with the old handwheel. Up to this time the machines used in the manufacture were of

the rudest kind, differing little indeed from those which had been employed in India from the earliest periods. The calico was generally woven by cottagers, who received from the masters a supply of linen yarn for the warp or long threads, and of raw cotton to be carded and spun for the "weft," these operations being generally allotted to the females of the weaver's family. But while the spinning had to be performed by no better machine than the old single thread-wheel, the incessant industry of the weaver's wife and children could not supply weft fast enough to keep pace with his loom, so that he was compelled to employ additional hands. Thus the complete dependence of the weaver on the spinners compelled him to pay them constantly increasing prices, and to submit without complaint to their caprices. It was a common thing for a weaver to walk three or four miles in a morning, and to call on five or six spinners before he could collect material enough for the remainder of his day's work; and when he wanted to complete an order in a shorter time than usual, the promise of a new ribbon or a new gown is said to have been necessary to quicken the exertions of the cottagers.

Arkwright, travelling through these districts, then a country of pure streams and skies unsullied by the smoke of a single factory chimney, saw and meditated upon this state of things. Like the collectors of "weft" he too was an itinerant purchaser of material for a branch of industry, and the houses he visited were those in which the spinning went on incessantly, and where the weaver continually called. His old broken models were, of course, not forgotten; his dreams of a machine to embody perpetual motion, were doubtless fading out;

but what if he could devise machines for supplying weft, or even the stronger threads, called warp, so fast that all the fingers in England could not keep pace with their powers? Some attempts had been made by Lewis Paul and other ingenious men, but they had met with violent opposition from the spinners. Arkwright, however, was not daunted; he had a notion that spinning might be done by means of two rollers, one of which revolving much faster than the other, would draw the twisted threads exactly as had been done by hand labour; a notion similar to that of Lewis Paul, but which he is said to have derived from watching the rollers employed to press out bars of redhot iron. The conception grew in his mind. One day he went secretly to Warrington, many miles from the town in which he resided, and employed a watchmaker, named Kay, to bend some wires and turn some pieces of brass for his purpose. Kay was then so far trusted as to be employed to make a small model under Arkwright's directions, and the latter then applied to a machinist in the town to make a working machine on the plan, a task for which the watchmaker was incompetent. The machinist, however, deterred by the poverty of Arkwright's appearance, and the doubtful character of the enterprise, hesitated to undertake it; but in the evening of the day on which he was applied to, he agreed to lend the watchmaker the assistance of a smith and toolmaker to make the heavier parts of the machine, while the watchmaker made the lighter portions under this man's direction. Thus, without funds, and without encouragement, the poor barber contrived to have constructed his first machine, the gigantic results of which even his

sanguine temperament could hardly have foreseen. This interesting relic has fortunately been preserved, and has been recently added to the collection in the Patent Museum at South Kensington.

CUVIER AND THE FOSSIL-FOOT.

WHILE the great naturalist Cuvier was astonishing the world by his great discoveries in geology and comparative anatomy, neither the grandeur of his subjects, nor the novelty of the truths which he brought to light, led his severely philosophic mind into rash hypotheses. The chalk quarries of Montmartre, in the neighbourhood of Paris, afforded him a continual supply of specimens of fossils, and every load of fragments brought from thence to his house by the Garden of Plants was studied with intense delight. At these quarries he employed, at his own expense, an intelligent workman to collect the bones continually found there; and all who could bring genuine specimens to his door were rewarded with as much liberality as his scanty fortune would allow. Before he had published his great discoveries, and when the expense of employing professional artists was beyond his means, he not only drew but engraved the plates himself, and many of these valuable proofs of his industry are scattered through his great work on fossil remains. Subsequently a M. Laurillard became his secretary, and was associated with him in these researches. Of the origin of Cuvier's friendship for

this gentleman we are told a characteristic story. Laurillard was a native of the same town as Cuvier, and had left his birthplace to pursue the profession of an artist, in which capacity he had executed some trifling work for the great naturalist, but without particularly attracting his notice. One day, however, Cuvier went to his brother's apartment to ask for some help in digging out a fossil from the mass of rock in which it was embedded. The young artist happened to be the only person to be found on the spot, and he cheerfully lent assistance. Little aware of the value of the specimen entrusted to his care, he succeeded in getting the bone out entire, thus succeeding almost beyond expectation in carrying out the wishes of Cuvier. In a short time the latter returned for his treasure, and when he saw how perfect it was, his ecstasies became uncontrollable; he danced, shook his hands, and uttered expressions of delight, till Laurillard, ignorant both of the importance of the discovery, and of the ardent character of Cuvier, thought he was mad. Taking the fossil-foot in one hand, and dragging Laurillard's arm with the other, Cuvier led him up-stairs to present him to his sister-in-law, saying, "I have got my foot, and M. Laurillard found it for me!" He had, indeed, long been meditating on the existence and form of a foot which he had vainly sought; so that when he appeared particularly absent, his family were wont to accuse him of seeking his fore foot. The next morning Laurillard was engaged as Cuvier's secretary, and proved an able coadjutor and faithful friend, destined to be remembered with his illustrious master as long as mankind shall be grateful towards the great discoverers in science.

STEPHENSON AND THE LAWYER.

Among the most interesting episodes in the career of George Stephenson are the contests which he was compelled to maintain with clever lawyers, who were employed to cross-examine him before committees of the House of Commons on the merits of the particular railways which he was engaged to construct. The late Baron Alderson, then a rising practitioner at the bar, was one of these tormentors of the untaught man of science. Mr. Alderson had a morbid dislike of change, and he is said to have conducted the cross-examination in the tone of a man hurt in his feelings by the idea of a steam train going through space at the rate of twelve miles an hour. The following is a good specimen of one of these scenes :—"'Of course,' (the question was put with reference to the proposed speed) 'when a body is moving upon a road, the greater the velocity the greater the momentum that is generated ?'—'Certainly.'—'What would be the momentum of forty tons moving at the rate of twelve miles an hour ?'—'It would be very great.'—'Have you seen a railroad that would stand that ?'—'Yes.'—'Where ?'—'Any railroad that would bear going four miles an hour; I mean to say that it it would bear the weight at four miles an hour, it would bear it at twelve.'—'Taking it at four miles an hour, do you mean to say that it would not require a stronger railway to carry the same weight twelve miles an hour ?'—'I will give an answer to that. Every one, I dare say, has been over ice, when skating, or seen persons go over ; and

they know that it would bear them at a greater velocity than it would if they went slower; when it goes quick, the weight in a manner ceases.'*—'Is not that,' asked the lawyer, with a triumphant glance at his audience, 'upon the hypothesis that the railroad is perfect?' But the witness was not to be taken aback. With an equally triumphant glance he replied immediately, 'Yes, and I mean to make it perfect.'"

The lawyer now started upon another tack:—"'Do not wrought-iron rails bend?' he asked; 'take Hetton Colliery, for instance?'—'They are wrought iron, but they are weak rails.'—'Do you not know that they bend?'—'Perhaps they may, not being made sufficiently strong.'—'And if made sufficiently strong, that will involve an additional expense?'—'It will.'—'You say the machine can go at the rate of twelve miles an hour. Suppose there is a turn upon the road, what will become of the machine?'—'It would go round the turn.'—'Would it not go straight forward?'—'No.'—What is to be the height of the flanch of the wheel?'—'One inch and a quarter.'—'Then if the rail bends to the extent of an inch and a quarter, it will go off the rail.'—'It cannot bend. I know it is so in practice.'—'Did you ever see forty tons going at the rate of twelve miles an hour?'—'No; but I have seen the engine running from eight to ten miles round a curve.'—

* There is, probably, some error in the report. In fact, the very reverse of this proposition is the truth. The principle now acted on throughout our railways, is, we believe, to slacken the speed of trains upon approaching bridges of any considerable length; and the same rule of going slowly is, we believe, always observed in passing over an unsound part of an embankment.

'What was the weight moved?'—'I think little, except the engine.'—'Do you mean to tell us that no difference is to be made between those forty tons after the engine, and the engine itself?'—'It is scarcely worth notice.'—'Then, though the engine might run round and follow the turn, do you mean to say that the weight after it would not pass off?'—'I have stated that I never saw such a weight move at that velocity; but I could see at Killingworth that the weight was following the engines, and it is a very sharp curve: it is a sharper curve there than I should ever recommend to be put on any railroad.'—'Have you known a stage-coach overturn when making not a very sharp curve, when going very fast.'—'Often enough,' replied the engineer, with a shrewd smile; 'but stage-coaches with a dozen passengers outside are top-heavy, and trains are not. You see that makes all the difference.'"

SAMUEL CROMPTON AND THE "SPIES."

One of the first inconveniences that Crompton experienced from the success of his "spinning mule," arose from the curiosity of the public concerning it. Numbers came eager to obtain a sight of it. When denied the house, they climbed up ladders to the windows, one even concealing himself for several days in the cockloft where he watched Crompton at work through a gimlet-hole pierced in the flooring. Arkwright himself was one of these visitors. Feeling the impossibility of preserving

a secret which every one could carry away with his eyes, Crompton at length resolved to throw it open to the public, though not unconditionally. Some friends and others were permitted to see it, among whom was Robert Peel, the father of the eminent statesman, who brought with him two mechanics to examine its construction. Crompton obtained a written promise of a subscription of a guinea each from a number of persons to recompense him for divulging his secret; but when the time came for calling in the subscriptions, many who had put down their names refused to pay, and when everything was gathered in and deductions made, Crompton found himself possessed of less than sixty pounds, just as much money as built him a new machine with only four spindles more than the one he had given up. Crompton felt the injustice done him so keenly, that one day he seized his axe and broke his carding machine to pieces, exclaiming, "They shall not have this too!"

THE WAR OF THE "KNOBS AND POINTS."

A SINGULAR kind of scientific feud arose in the reign of George III., out of Franklin's discovery of the power of rods and points in conducting and drawing off electricity. Franklin had modestly inquired whether the knowledge of this power might not be of use to mankind in preserving houses, churches, or ships from lightning, by directing us to fix on the highest parts of those edifices

upright rods of iron made as sharp as a needle, and thus "drawing the electrical fire silently out of a cloud before it came nigh enough to strike, and thereby secure us from that most sudden and terrible mischief." Experiments proved to Franklin's satisfaction the truth and great importance of this suggestion; but the Abbé Nollet, a great authority in France on Natural Philosophy, solemnly warned the Academy of Sciences in a memoir read before them against "those iron points which people are erecting in the air," and which, he asserted, were more calculated to bring destruction upon a building than to ward it off! In England, however, the great philosopher's discovery was received with more favour. The Dean and Chapter of St. Paul's, alarmed by the fact of St. Bride's Church, Fleet Street, having been struck by lightning and seriously injured, applied to the Royal Society for advice against a similar accident to the cathedral; and they were recommended to "make a complete metallic communication between the cross placed over the lanthorn and the leaden covering of the great dome." This was done about 1769, and the water pipes already existing were made to serve as conductors from the roof to the ground. A year or two later, the Royal Society were called on by the Government to advise for the protection from lightning of the powder magazines at Purfleet, and a committee of the society strongly recommended the use of *pointed* conductors.

Then, for the first time, arose a controversy which afterwards assumed historical importance. One member of the committee, named Wilson, protested that he was in favour of knobs instead of points to the con-

ductors, being apparently under the impression that points invite the stroke. Points were ultimately adopted but unfortunately some countenance was given to the knob theory, by the circumstance that the magazines were struck by lightning in 1777, and slightly injured, though the powder was not exploded, while a house at Tenterden similarly furnished was also struck. The opponent of points now claimed a triumph; but a committee of the Royal Society, composed of the most eminent men of science of the time, made experiments and again reported in favour of points. Wilson was greatly incensed at this new decision against his favourite notion. Parties were formed on either side, and the fact that Franklin was one of the most conspicuous of the "rebels," then waging war with the king's troops in our American colonies, quickly gave to a purely scientific question a political significance. The advocates of blunt points soon became identified with the insurgent colonies, while the opponents of "knobs" were considered disaffected subjects. The populace, and even the higher classes of society took up the quarrel, without knowing anything of its scientific merits; and to put up rods without knobs was a sure way to lead to a breach of the peace. Meanwhile the king, in defiance of the judgment of the men of science, ordered all point-conductors to be removed and knobs to be substituted. The good Franklin wrote with a dash of bitterness, which may be pardoned to the feelings of the illustrious "rebel." "I have never entered into any controversy in defence of my philosophical opinions; I leave them to take their chance in the world. If they are right, truth and experience will support them; if wrong, they ought to be

refuted and rejected. Disputes are apt to sour one's temper and disturb one's quiet. I have no private interest in the reception of my inventions by the world, having never made, nor proposed to make, the least profit by any of them. The king's changing his pointed conductors for blunt ones is, therefore, a matter of small importance to me. If I had a wish about it, it would be that he had rejected them altogether as ineffectual. For it is only since he thought himself and family safe from the thunder of heaven that he dared to use his own thunder in destroying his innocent subjects." The king, it is said, actually endeavoured to make the Royal Society rescind their resolutions in favour of the hateful points, and had an interview with Sir John Pringle, the then president, during which he earnestly entreated him to use his influence in supporting Mr. Wilson. The reply of the president was dignified and worthy of his position. "My duty, sire," he said, "as well as my inclination, would always induce me to execute your Majesty's wishes to the utmost of my power, but I cannot reverse the laws and operations of nature." The king, less easily satisfied than King Canute with this kind of answer, is said to have replied petulantly, "Perhaps, Sir John, you had better resign." It was in allusion to this affair that a friend of Franklin's penned the following highly treasonable epigram :—

"POINTS OR KNOBS."

While you, great George, for knowledge hunt,
And sharp conductors change for blunt,
The nation's out of joint;
Franklin a wiser course pursues,
And all your thunder useless views
By keeping to the point.

THE STORY OF "WEDGWOOD-WARE."

Josiah Wedgwood, whose name must always be associated with the history of pottery and porcelain, was born at Burslem, in Staffordshire, in 1730, and was the son of a very poor man who laboured at that place as a potter, or maker of the rude kind of earthenware then in use. Even the better classes at that time ate their meals off pewter or brass platters, while foreign china, and indeed all but the rudest pottery, was regarded rather as an ornament for sideboards or mantelpieces than as a thing of real utility. Simeon Shaw, the historian of Staffordshire, says, that scarcely any person in Burslem learned more than mere reading and writing till about 1750, when some individuals endowed the free school for instructing youth to read the Bible, write a fair hand, and know the primary rules of arithmetic. Shaw tells us also that at eleven years of age, his father being then dead, Wedgwood was working as a thrower in his elder brother's pottery. Shortly after this, the small-pox—that terrible scourge which, as yet, no Jenner had arisen to subdue—attacked the lad, and after a long and miserable illness left him with a lameness in his left leg which, afterwards rendering amputation necessary, compelled him to quit the monotonous drudgery of the potter's wheel.

When a young man he left Burslem for awhile, and entered into a sort of partnership with another working potter, named Harrison, at Stoke, in the neighbourhood. The partnership lasted but a short time; for the young

potter from Burslem spent more time in designing improvements in the shapes and patterns of the articles they manufactured, than was likely to be approved of by a partner of alessspeculative turn of mind. It was here that Wedgwood's talent, or rather his passion for producing ornamental pottery, began to develope itself. He returned to his native place and entered into a new partnership with a potter named Wheildon, devoting himself to the designing and manufacturing of knife-handles, in imitation of agate and tortoiseshell, melon table-plates, green pickle leaves, and similar kinds of porcelain ware. His new partner, however, was not more indulgent than the Stoke potter towards new-fangled manufactures, which diverted his attention from the ordinary departments of the pottery business, in which he found a sufficiently profitable field for his industry. It is evident that, although he was a practical potter, Wedgwood's partners looked upon him as a dreamer, and were suspicious of his predilections for devising and inventing. The second partnership ended like the first, and at the age of twenty-nine Wedgwood again repaired to Burslem; but this time not to be curbed by the will of any partner, but to show those who had refused to support him in his day dreams how much they had lost by their short-sightedness.

In a small thatched house at Burslem, happy in being his own master at last, the Stoke potter devoted himself alone to the accomplishment of his long-cherished dream of creating a demand for something higher, by improving the productions of his art. Here he began to prosper; took a second manufactory, in which he fabricated a white stoneware, and subsequently established

himself in a third, where he produced that cream-coloured ware by which he gained so much celebrity. Of this new kind of pottery Wedgwood was permitted to present some specimens to Queen Charlotte, who therefore ordered a complete table-service—the first royal table-service of English manufacture which had been used—and was so pleased with its execution as to appoint him her potter, and to desire that his manufacture might henceforth be designated "The Queen's ware." Wedgwood had observed that a certain earth which contained silica, and which was originally black, became white after burning it in a furnace. Meditation on this fact led him to the notion of mixing silica with the red powder of the potteries, and to the discovery that the mixture became white when calcined. Only one step more remained. By coating this material with a transparent vitrification, commonly known as the glazing, he produced that English earthenware which has become so widely used, and which now figures so largely in the list of our exportations. Suddenly six different kinds of stoneware, hitherto supposed to be unproducible in this country, made their appearance from his manufactory in Staffordshire, delighting and astonishing the connoisseurs, and causing no small consternation among the possessors of valuable old china, who saw a prospect of their treasures being diminished in value by the unexpected discovery that an Englishman could rival the best productions of foreign art.

THE RAILWAY IN ITS CRADLE.

NEARLY ninety years ago an enthusiastic mechanic, named Oliver Evans, was notorious in the city of Philadelphia in the United States, as the advocate of a wild scheme for using steam as a locomotive power. Like most earnest men, Evans was considered by his acquaintances as somewhat of a "bore;" and his notions of "expansive force," and of turning a destructive enemy into a "useful servant," were generally met with derision. But Evans only held on the closer to his favourite notion. In 1787 he actually obtained from the state of Maryland an exclusive right to make and use steam waggons, and he offered to make a steam carriage that "would run on a level road with the swiftest horse," and at another time to furnish steam carriages that would "run at the rate of fifteen miles an hour on good level railways." His countrymen, however, took no heed of him. He was undoubtedly somewhat of a visionary; but however defective in details his contrivances may have been, time has shown that the objects he undertook to accomplish were attainable. The unfortunate Oliver Evans, however, cried in vain to be heard. He died neglected, and was forgotten.

It was seventeen years later that the exhibition on the Merthyr Tydvil Railway took place; but no less than ten years elapsed before any considerable advance can be said to have been made in the application of steam to locomotion on land. The great obstacle was the supposed want of hold or adhesion of the wheels

upon the rails. No want of adhesion had been actually experienced by any one, but people generally assumed that such would be the case, and that was all. Had but a single experiment been made to ascertain whether "want of hold or adhesion" was really the sort of obstacle which it was supposed to be, ten or fifteen years of inventing and contriving to overcome that obstacle would have been saved, and the talent and ingenuity thrown away on the visionary pursuit might, when applied—as it would have been—to a removal of the real difficulties, have gained just so many years' march on the road of improvement.

The world may be said to have slept in the belief that locomotive engines could not drag trains along lines of rail until 1812. In that year the "viewer" of the Wylam Colliery, near Newcastle-upon-Tyne, was an ingenious man, named William Hedley. It was the year of Napoleon's retreat from Russia, when his gigantic army perished in the snows—a terrible year of cold and distress, when wheat in England reached the highest point it had attained for these hundred years, and famine stared the people in the face. The trouble which, however, day and night haunted the mind of William Hedley, was the high price of fodder for cattle. All the coals from the Wylam Colliery were carried by a long tramway in trucks dragged by horses to the place of shipping; and Hedley knew well that unless something could be invented to supersede horses in the conveyance of the coals, it would be impossible to continue to work the tramway. He saw nothing before him but the prospect of the closing of the colliery, and of himself and his wife and family being cast on the

world. In a state of despondency he retired to bed one night in the autumn of the year 1812; but it was not to find repose. Suddenly the idea flashed across his mind that if all the wheels of a moving carriage were connected, a tendency in any particular set of wheels to surge or revolve on their axes without moving forward, might possibly be overcome by the remaining wheels. He determined to ascertain if this was the fact. On the following morning he ordered a frame and wheels to be made, and with the help of a clockmaker in Newcastle, completed his model.* It was successful, and he had the satisfaction of seeing his notions realized within twenty-four hours; and eventually he had the happiness of inventing and building the first locomotive engine moving by the friction of the wheels upon the road. It was extremely slow in its movements, but it served his purpose, and above all consumed neither hay nor oats, wanted nothing, in short, but that coal in which the neighbourhood abounds.

The original Wylam locomotive is now in the Patent Museum at South Kensington. A rude, old weather-beaten rusty machine of gigantic size and ponderous appearance, it was nevertheless in constant use at the colliery from 1813, when it was constructed, until June, 1862, when it was removed to the honourable asylum in which it now finally rests from its labour. At Wylam it was called by the country people "Puffing Billy," from the great noise it made, and it never received any other name. The career of "Puffing Billy" had almost been brought to a premature close, while its owner narrowly escaped a lawsuit in his defence. His perpetual puffing and snorting along the road was voted a

nuisance; landlords complained, and great lawyers were appealed to on legal cases solemnly drawn up. But "Puffing Billy" was too good a friend to Newcastle folks to be allowed to be put down. The colliery went on, William Hedley retained his employment, remained at Wylam for many years, and died in 1842.

THE FIRST HOT-PRESSER OF PAPER.

THE practice of hot-pressing, by which so beautiful a gloss and flatness is given to printed paper—particularly that used for expensive books—was the invention of Mr. Thomas Turnbull, the founder of the well-known firm of cardboard makers of that name.

Eighty years ago, as all persons know who have looked over old letters of that period, writing papers were made with an extremely rough surface, on which it now seems difficult to understand how pens could have been made to mark. Even the system of "rolling" was then unknown; and printing paper was invariably disfigured by a coarse surface, while the impression of the type, where the paper was not thick, was generally to be seen through the reverse side. Our forefathers probably thought such matters unworthy of serious attention; although now every stationer and bookseller knows that the public have since learned to regard them as important. No one, at all events, had hitherto

thought of remedying them; and the improvement finally came from the ingenious idea of a man in no way connected with paper-making or publishing. Thomas Turnbull was a young workman in the employment of Mr. Sparrow, a packer and hot-presser of cloths—which were the only articles then hot-pressed. Mr. Sparrow having died, a number of circulars announcing the fact to his customers were ordered by his widow to be printed. The circulars, when they came from the printer's, damp and uneven, with printmarks on the back, were disagreeable to the eye of the young workman; he had a leisure half-hour, and it struck him to put each between glazed boards and subject the printed paper to the same pressure from hot iron plates screwed down by powerful machinery, which he had been accustomed to give to cloth and silk. The result showed an improvement so striking that he was at once convinced that the new application of the process, trifling as it seemed, was important. Having an enterprising mind, he soon afterwards took a small shop in Booth Street, Spitalfields, set up presses, and went himself to stationers and publishers with specimens of his work. The system spread, although, as in the case of other luxuries, it was at first ridiculed as an absurd piece of foppery. Mathias, in his satirical poem, entitled "The Pursuits of Literature," published in 1794, frequently denounced the new absurdity. "All books," he says, "are now advertised to be printed on wire-wove paper, and *hot-pressed*, down to the 'Philosophical Transactions' and Major Rennell's learned 'Memoir on Hindostan,' as if the intention were that they should be looked at and not read." Thomas Turnbull extended the hot-pressing

system to cardboard making, in which art he gained a great reputation, which is still enjoyed by his descendants.

BRUNEL'S PROPHECY.

The elder Brunel, who was a Frenchman, and born in Normandy, had from his earliest years a desire to visit the country which he afterwards adopted as his own, and in which he subsequently made his reputation. When a boy, he frequently went to Rouen, that great mercantile city to which, in spite of the foolish restrictions which so long encumbered the French mercantile laws, some productions of British skill and industry have always found their way. Here his attention was constantly excited by two large cast-iron cylinders which had been landed and were allowed to remain upon the quay. Compared with his own height they seemed to him gigantic, and he was curious to know their history, what was their use, and whence they came. At last a man aboard a ship alongside the quay beckoned to him to come down the ladder, and offered to tell him what he had heard the boy asking for. The kindly sailor man told the boy that the cylinders were part of a "fire" engine—for so steam engines were called in the early days of their history; that they were just arrived from England, where the people were constantly making such things, and chiefly to be used in raising water where human strength, or even horse power, would be

ridiculously insufficient for the purpose. The boy listened eagerly, and then, according to Mr. Beamish, exclaimed, "Oh, when I am older, how I shall like to go and see that country!" The quay at Rouen, after this, became a favourite loitering-place for him; and on another occasion seeing here the different parts of a carriage recently landed, he said, "How clever the folks are in that country! I shall go to see it when I am older." Brunel remembered these words long afterwards as something almost prophetic of the future career of the engineer of the Thames Tunnel, which so many foreigners now visit as one of the most remarkable sights in this engineering country.

The Reign of Terror in 1793 drove Brunel from France. He was then twenty-four years of age. In his sixty-ninth year, during a suspension of the works of the Thames Tunnel, he paid a visit to his native town of Hacqueville. He records this visit pathetically in his diary, in his original language, "I met no one whom I knew," he says, "but Penchon the joiner. Penchon must be seventy-two years of age now. I spoke to him as he was looking from his window. He did not know me. I entered by the window, to his great astonishment, and told him who I was. He showed me a part of the first frame of an instrument which I had attempted, and afterwards succeeded in making; then some wheelwork, and other things. He called his wife, a beautiful woman fifty years ago, now aged like himself. She regarded me with a bewildered look for some time without speaking, and then exclaimed, "Ah! it is Monsieur Isambard; but, oh, how he is changed!"

THE BOY AND THE STEAM ENGINE.

The story of Humphrey Potter, the Cornish boy, who invented the self-acting valve for Newcomen's rude steam engine, is strikingly told by M. Arago the great astronomer. Newcomen's first engine required the most uninterrupted attention from the person who had to open and shut the taps, either to introduce the steam into the cylinder or to throw in the cold shower intended to condense it. It happened on a certain day that this person was young Potter. The companions of this child were then at play, and their exclamations of joy tantalized him severely. He longed to go and join them; but the task entrusted to him would not allow of half a minute's absence. His mind became excited; strong passion awoke his genius, and he discovered relative connections of which he had never dreamt before. Of the two taps, the one was to be opened at the moment when the beam that Newcomen had been the first to introduce to such good purpose in his engines had completed the descending oscillation, and it must be shut exactly at the opposite oscillation. The management of the second tap required to be the exact contrary. The positions of the balance and of the taps were necessarily dependent on each other. The boy's quick invention seized on this fact. He perceived that the beam might impress on the other pieces all the motion that the play of the engine required, and instantly realized his conception. Several cords were quickly fastened to the handles of the taps; the opposite ends Humphrey Potter

tied to portions of the beam suitably selected. Thus the purchase which this exercised on certain cords while rising, and those that it exercised on others in descending, supplanted the manual efforts. For the first time the engine worked by itself; for the first time no other workman was seen near it but the stoker, who from time to time went to keep up the fire under the boiler. For the cords which the boy used the constructors soon substituted rods fixed to the beam, and furnished with several pegs, which pressed the heads of the taps or valves either downwards or upwards. The rods themselves have long ago been exchanged for other combinations; but in the words of M. Arago, however humiliating such an acknowledgment may be, all these inventions are mere modifications of the mechanism suggested to a child by the wish to join his little companions at play.

DR. BUCKLAND WATCHING THE BUILDERS.

Among other anecdotes told of the late Dr. Buckland, to whom we are indebted for many geological discoveries, we are told that he looked very sharply after the masons when repairing Westminster Abbey, or any other of the collegiate buildings in which he had any interest, examining the various kinds of cements, the blocks of building-stone, the means adopted to repair and keep in order the regal and other monuments; and taking special care that no faulty bits of stone, etc., were used.

Many years ago, when the turrets of a certain tower, of Christ Church, Oxford, were undergoing repairs during the long vacation, he had reason to suspect that all was not right. It was almost impossible for him to ascend by the slender scaffolding to these turrets; so, from the window of his house (he was then Canon of Christ Church) he bethought him of watching the masons through the telescope (a very good one) with which he used to examine distant geological sections. At last the unsuspecting mason, working, as he thought, far above the ken of man, put in a faulty bit of stone; the learned doctor, on the look-out below, detected him through the telescope, and almost frightened the man out of his wits, when, coming out into the quadrangle, he admonished him to bring down directly "that bad bit of stone he had just built into the turret."

AN IMPROMPTU INVENTION.

A REMARKABLE illustration of the truth that ingenious men, probably from the habit of grappling with difficulties, frequently overlook simple and obvious means of attaining their objects, is afforded by an anecdote related of the origin of Arkwright's partnership with Mr. Strutt, the well-known patentee of the stocking frame, who was the first to appreciate the machine for spinning by rollers. A serious defect in that machine, and one which had cost its inventor much annoyance,

was the tendency of the rollers to catch and hold the fibres of cotton. The defect having been noted by Mr. Strutt, Arkwright confessed that he had found it irremediable. "I think I can cure it," remarked the former, "but it must be on condition of sharing the profits." So beneficial an offer was immediately acceded to; the terms were agreed on, and Arkwright and his new partner entered the mill. Here Mr. Strutt simply took a piece of chalk from his pocket and rubbed the roller thoroughly, bidding his companion try the effect. The success was complete—the clinging of the cotton fibres was instantly at an end. Simple as was the remedy, it had attained its object, and fairly earned for its shrewd inventor the reward for which he had stipulated.

THE FIRST PHOTOGRAPHERS.

It has long been known that at the beginning of the present century Josiah Wedgwood, the famous potter, Sir Humphrey Davy, and James Watt, made experiments upon the action of light upon nitrate of silver; but it is only lately that evidence has been found of the fact of their having succeeded in any degree in permanently fixing the image thus obtained. Some person searching for other purposes in an old lumber room which belonged to Watt's partner Matthew Boulton, discovered a silvered copper plate, having on it a representation of the old premises at Soho, which appeared to have been evidently taken by a photographic process. This plate is now included in

the collection at the Museum of Patents, at South Kensington. In the account published of it, it is stated that an old man of ninety, recently dead, or still alive, remembers that Watt and others used to take portraits of people in "a dark room"—the latter fact meaning, probably, nothing but that they were taken secretly; for there is a letter extant of Sir William Beechey, begging the philosophical body at Birmingham, calling themselves the "Lunar Society," to desist from these experiments, as were the process to succeed it would ruin portrait painting.

WILLIAM FLAKEFIELD'S LINEN HANDKERCHIEF.

The writer of a recent work recommends to the people of Glasgow the erection of a statue to a now almost forgotten hero, William Flakefield; and that great manufacturing city can certainly have had few benefactors more worthy of that honour. The story of William Flakefield, whose true name was Wilson, is somewhat romantic.

Wilson and his father and brother, poor Scottish weavers, settled in Glasgow in the time of William III. The townspeople, to distinguish William from his brother, commonly called him Flakefield, which was the name of the place in the parish of East Kilbride in which he had lived, and finally he adopted the name. Being a fine young fellow he joined the Scottish Guards, and accompanied the army to the Low Countries where the war was then raging. Here he was struck one day

with a handkerchief which he had bought, of a simple pattern woven in blue and white. Simple as it was, the eye of the weaver detected beauty in it, and it was at least far superior to the coarse productions of the looms of his native country—at least of those which produced cheap goods for the humbler classes. Flakefield never parted with his handkerchief, but kept it carefully, determining, if he was able, to weave one like it when the opportunity should offer. He came back to Scotland in 1697, when the peace was concluded with France; and settling down again, hung up his sword and belt in his weaver's garret, and once more pursued his labours with the peaceful shuttle. He had still in his possession the white and blue pocket-handkerchief, the companion of his wanderings; and after many obstacles, scarcely to be imagined in these days of improved machinery and appliances, succeeded in making one exactly like it. In a short time he had a dozen ready for sale; the first, it is said, of the kind woven in Great Britain. The pattern was liked by the Scottish people, and was soon seen both among the poor townsfolk and the humble peasants to whose home the indefatigable pedlar of those times took them in their wanderings. Looms rapidly increased; and in a few years Glasgow became famous for this new branch of the linen trade. Many indeed profited by the manufacture and sale of Flakefield's handkerchiefs, except the poor weaver himself. He had but little capital; and his idea once seized upon, he could not of course compete with the rich employers of labour who adopted it. Flakefield, it is said, died in the humble position of the town drummer.

THE CHILDHOOD OF JAMES WATT.

Watt was, from his birth, of an extremely delicate constitution, unfitted for taking part in the common sports of boys, and little prepared for those struggles with difficulties which afterwards marked his career. His mother, who was a woman no less remarkable for her intelligence than for her personal graces, taught him to read when scarcely out of his infancy; and his father, who was a ship's carpenter and dealer in naval stores at Greenock, added a little writing and arithmetic. In the latter the child rapidly improved, and he was fond of working out his sums with a pencil upon scraps of paper, or more commonly with a piece of chalk upon the floor, sometimes his only amusement when the severe headaches to which he was subject compelled his parents to keep him at home. On one occasion when he was bending over a stone hearth with the usual piece of chalk, a visitor who was present remarked to the father, "The boy ought to be sent to a public school, and not permitted to idle away his time at home." "Look at what my child is doing before you blame him," returned the father. The child of six years of age was endeavouring to solve a problem in geometry. Another time he was scolded by his aunt Mairhead, while taking tea with the Watts, for his assumed indolence. "Jemmy," said the worthy lady, solemnly, "I never saw such an idle boy as you are. Pray take a book and employ yourself usefully; for the last hour you have not spoken one word, but taken off the lid of that kettle and put it on

again; holding now a cup and now a spoon over the steam, watching how it rises from the spout, catching and counting the drops it falls into. Are you not ashamed of spending your time in that way?" The little James playing with the tea-kettle, observes M. Arago, who tells this story, became the mighty engineer preparing the discoveries which were to immortalize him.

THE YOUTH OF JAMES WATT.

When he had left the grammar-school of his native town Watt received no more scholastic education; but then began that system of self-culture which he pursued to the end of his long life. He was, naturally, a solitary lad, and liked to ramble among the fine scenery in the neighbourhood of Greenock. The few old nautical instruments which he found among his father's stores inspired him with a curiosity on the wonders of astronomy, for he could not, throughout life, see a machine or instrument without a longing to understand its uses. By the time he was fifteen, he had twice read with great attention S'Gravesande's Elements of Natural Philosophy. While under his father's roof he went on with various chemical experiments, repeating them again and again until satisfied of their accuracy. When only seventeen he made himself a small electrical machine, an instrument at that time but little understood. He also read eagerly books of medicine, and

even practised dissection; for on one occasion he was found carrying away the head of a child who had died of some unusual disease; a remarkable instance of his suppression of his own feelings in his pursuit of scientific truth, for suggestions of suffering or disease were always peculiarly painful to him. In later life he said that, "had he been able to bear the sight of the sufferings of patients he would have been a surgeon." Botany and mineralogy were among the subjects which he studied in the open air in the neighbourhood of his native town. He read every book which fell in his way, and which promised to enlighten him upon some branch of inquiry. To a friend who blamed him for reading so many different kinds of works, he replied, "I have never yet read a book, or conversed with a companion without gaining information, instruction, or amusement."

BENJAMIN HUNTSMAN AND THE PROCESS OF MAKING CAST STEEL.



The story of how Benjamin Huntsman, the inventor of the art of making cast steel, was deprived of the secret of his art is told with great force and picturesque power in Dr. Scoffern's valuable little work entitled, "The Useful Metals and their Alloys."

One cold winter's night, says the writer referred to, while the snow was falling in heavy flakes, and Huntsman's manufactory, near Sheffield, threw its red glare of

light over the neighbourhood, a person of the most abject appearance presented himself at the entrance, praying for permission to share the warmth and shelter which it afforded. The humane workmen found the appeal irresistible, and the apparent beggar was permitted to take up his quarters in a warm corner of the building. A careful scrutiny would have discovered little real sleep in the drowsiness which seemed to overtake the stranger; for he eagerly watched every movement of the workmen while they went through the operations of the newly-discovered process. He observed, first of all, that bars of blistered steel were broken into small pieces, two or three inches in length, and placed in crucibles of fire-clay. When nearly full, a little green glass broken into small fragments was spread over the top, and the whole covered over with a closely-fitting cover. The crucibles were then placed in a furnace previously prepared for them, and after a lapse of from three to four hours, during which the crucibles were examined from time to time to see that the metal was thoroughly melted and incorporated, the workmen proceeded to lift the crucible from its place on the furnace by means of tongs, and its molten contents, blazing, sparkling, and spurting, were poured into a mould of cast iron previously prepared; here it was suffered to cool, while the crucibles were again filled, and the process repeated. When cool, the mould was unscrewed, and a bar presented itself, which only required the aid of the hammer-man to form a finished bar of cast steel. How the unauthorized spectator of these operations effected his escape without detection tradition does not say; but it tells us that, before many months had passed, the Huntsman

manufactory was not the only one where cast steel was produced.

This man is believed to have been an ironfounder, named Walker, who carried on his business at Greenside in the neighbourhood, where it appears clear that the making of cast steel, which had cost Huntsman so many years of toil and expense, was shortly afterwards commenced. Huntsman was of German extraction, and was born in Lincolnshire in 1704. He was apprentice to a clockmaker and mender, where he learnt to repair clocks and roasting-jacks, and developed a mechanical turn. He also became an itinerant vendor of remedies for diseases. It was the difficulty which he experienced in obtaining good springs and pendulums for his clocks which first led him to turn his attention to the manufacture of a better kind of steel than was then procurable, and thus conducted him by laborious steps to those important discoveries which are identified with his name.

THE FICTION OF SALOMON DE CAUS.

A FEW years ago, the French public were startled by the announcement that evidence had been discovered that the glory of the invention of the steam-engine had been erroneously assigned to England; the idea at least having been anticipated by a Frenchman long before Watt, or even Savery or Newcomen had been heard of. The form in which this story was brought forward was

that of a letter purporting to be written by the celebrated Marion de Lorme in 1641, and addressed to her lover, Cinq-Mars, informing him that in doing the honours of Paris to his English friend, the Marquis of Worcester, she had accompanied him to the famous madhouse in the environs of that city, called Bicêtre, and that here they had heard a miserable captive exclaim from behind his bars, "I am not mad! I am not mad! I have made a discovery which would enrich the country that adopted it." The letter then relates that the writer and her companion ascertained from a keeper that this was one Salomon de Caus, who had written a book of which the keeper at once produced a copy, after a perusal of which the Marquis requested an interview with the madman, and on leaving Bicêtre declared that in it was confined the greatest genius of the age. The discovery, coupled with the fact that M. Arago, in a celebrated article on the History of the Steam-engine, published in a French scientific journal, had aroused the attention of his countrymen to the respective claims as inventors of De Caus and the Marquis of Worcester, served to confirm the belief that De Caus was the originator of the idea of turning the expansive force of steam to useful purposes. The idea of a great discoverer perishing unheeded in a public madhouse struck the imagination of artists. A painting at the exhibition of the Louvre, of the miserable De Caus raving through the bars of his dungeon at the heedless woman of fashion and her shrewd companion, had a great success, was multiplied by lithography and engraving, and appeared in a London illustrated newspaper. A drama, also founded on the main incident of the anecdote, was a few years since per-

formed in London and Paris; and grave biographical dictionaries, on the faith of the alleged letter of Marion de Lorme, inform their readers that it is now proved in the most positive manner that De Caus ought to be regarded as the inventor of the steam-engine.

This singular imposture has now, however, been completely exposed. Mr. Muirhead, in his life of Watt, remarked that the tone and language of the letter betrayed throughout its modern origin; and also that in 1641 there was no Marquis of Worcester at all, that title having first been conferred on Henry Somerset, in 1642, who moreover was not the marquis who wrote the "Century of Inventions," but his father. To these facts, conclusive in themselves, a French writer, M. Figuier, adds among other things the criticism that, as Salomon de Caus died in 1630 he could hardly be found shut up in a madhouse in 1641; and that, moreover, Bicêtre was at that time not a hospital at all. It appears that this pretended letter was first published in a French periodical entitled, "The Musée des Familles," a kind of French penny magazine in 1834. Such is the authority on which this palpable fraud has for some time been invested with the dignity of history.

THE INVENTOR OF PRINTING FOR THE BLIND.

The whole credit of the beautiful invention of printing for the blind, so simple yet so marvellous in its results, belongs to France. It was Valentine Haüy, who, in

1784, at Paris, produced the first book printed with letters in relief, and soon afterwards proved that children might easily be taught to read with their fingers. It is stated by his biographer that he took his idea of embossed typography from seeing that a blind pianist from Vienna, who visited Paris that year, distinguished the keys of her instrument by the sense of touch, and also readily comprehended the maps in relief, which a short time before had been invented by a German. After employing letters of different forms and sizes, and experimenting with the blind as to the precise shape of the letter that could be the most readily distinguished by the touch, he at length fixed upon a character differing very slightly from the ordinary Roman letter, or perhaps a little approaching italics. He submitted his first efforts and experiments to the Academy of Sciences of Paris, and their favourable report rendered his success a triumph. Great *éclat* attended the public announcement of this invention. A new institution was established, called the Royal Institution for young Blind Persons, and Haüy was placed at the head of it. Among the books which he embossed were a grammar, a catechism, and small portions of the Church Service, and also several pieces of music. The printing of the music was inferior. His principal work, on the subject of his invention, was published in Paris in 1786. This celebrated essay was translated into English by Dr. Blacklock, the blind poet, and published.

Twenty-four of Haüy's pupils exhibited their attainments, in reading, writing, arithmetic, music, and geography, before the unfortunate Louis XVI. and the royal family at Versailles, who were delighted with the

wonderful results. For a while all went on prosperously, but as the novelty wore away, the admiration of Mr. Haüy's friends cooled, the funds fell off, and the institution languished until it was put upon a government foundation. The blind really received but little advantage from an invention that at first promised so much. The fault, however, seems to have been not so much in the plan as in the execution of it. The books were bulky and expensive, and the letters, though beautiful to the eye and clearly embossed, wanted the sharpness and permanence essential to perfect tangibility. This noble invention, except, perhaps, within the walls of the institution, soon sank into oblivion, and very little more was heard of it until 1814, when Haüy was pensioned, and Dr. Guillié, an active and enterprising gentleman, was made director-general in his place. Dr. Guillié soon revived the printing, and having considerably modified the letters, commenced the publication of a series of elementary and other works—the mechanical execution of which was exceedingly heavy. Most of them were ponderous folios and very expensive, still they formed for many years almost the only literature of the blind, not alone in France, but in other countries. One of them—an historical notice on the instruction of young blind persons—contains a curious specimen of printing in relief, in colour, so as to render the letters more easily read by the eye. This book was a valuable contribution to the library of the blind, but it could only be read by those possessing a very delicate touch. It is filled with information respecting the means then employed for the instruction of the blind in Paris; it proves, however, that the art of embossed typography had made

but very little progress. It is a reproach to this book that it makes no mention of the author's predecessor, Haüy, to whom the idea of finger-reading is due.

It was in Great Britain and in the United States that the first improvements were made in embossed typography, and only within the last thirty years that the blind generally have derived any considerable advantages from books. Before 1826, when Mr. James Gall, of Edinburgh, first began to turn his attention to the intellectual and moral education of the blind, it is believed that not a single blind person in any public institution of this country or America could read by means of embossed characters. To Mr. Gall is due the credit of reviving this art. On the 28th of September, 1827, he published "A First Book for Teaching the Art of Reading to the Blind," which is believed to be the first book printed for the blind in the English language. Thus while printing for the blind, which only lately was considered merely a curious or doubtful experiment, it is now established beyond all question that books are true sources of profit and pleasure to them. Embossed books have rapidly increased, and happily blind readers have multiplied still more rapidly.

THE ROMANCE OF THE STOCKING FRAME.

On the wall of a chamber in the old hall of the Framework Knitters' Society of London, now pulled down, there stood, in the days of George II., an ancient painted

wood carving which must always have attracted the attention of visitors. It represented the arms of the Company, which consisted of a stocking-frame without the woodwork, with the figure of a clergyman on the one hand and that of a woman on the other, forming what are called the "supporters." This singular heraldic device related to the romantic story of the invention of the stocking-frame by the Reverend William Lee, a native of Nottinghamshire, in the reign of Queen Elizabeth. The anecdote has been variously told, but no version appears better authenticated than that collected about forty years ago by Mr. Henson, a journeyman knitter, who, living by his daily labour in the lace frame at Nottingham, devoted all his leisure time to self-cultivation and to collecting materials for a history of the craft of which he was a member. The story was gathered by him chiefly from the narratives of "ancient stocking-makers," who all gave a similar account, doubtless inherited through many generations of workers at the frame.

Lee, it is said, paid his addresses to a young woman in his neighbourhood, to whom, from some cause, his attentions were not agreeable; or as, with more probability, it has been conjectured she affected to treat him with negligence, to ascertain her power over his affections. Whenever he paid his visits, she always took care to be busily employed in knitting, and would pay little attention to his conversation. This conduct she pursued to such a harsh extent, and for so long a period, that the lover became disgusted, and he vowed to devote his leisure, instead of following the whims of a capricious woman, in devising an invention that should effectually supersede her favourite employment of knitting. So

sedulous was Lee in his new occupation, that he set aside everything to accomplish this new object of his attentions; even his sacerdotal duties were neglected. In vain did the lady now endeavour to reclaim him. All interests, all avocations, all affections, were absorbed in his new pursuit, from which he imagined he should realize an immense fortune. His curacy was despised, and at length abandoned, as beneath the notice of a person who had formed in his imagination such gigantic prospects. For many years afterwards the old stocking-makers, particularly those in London, were fond of dilating in their cups on the difficulties he encountered. He had watched his mistress with the greatest attention while knitting, and he observed that she made the web loop by loop, but the round shape which she gave to the stocking from the four needles, greatly embarrassed him in his notions of destroying her trade by making a whole series or course at once, having as many needles as loops. It seemed impossible to construct a machine to make a round web. Pondering in his mind on the difficulties of his task, during one of his visits he found her knitting the heel of a stocking, and using only two needles; one was employed in holding the loops while the other was engaged in forming a new series. The thought struck him instantly that he could make a flat web, and then by joining the selvages with the needle, make it round. From that moment his whole soul was devoted to the object which presented difficulties in that age, which nothing but enthusiasm could have overcome.

At the end of three years' study and patience, Lee was enabled to make a course upon the frame; but here new obstacles presented themselves. He wrought

with great facility the top, the narrowings, and the small of the leg; but the formation of the heel and the foot still embarrassed him. It is stated, that misled by the method of fashioning stockings by the knitting-needles, when he arrived at the length where the heels were to be formed, he worked the heels alone, and brought the instep by the hand under the hook of the needle previous to pressing; and that it was some months before he discovered the method of working them together. Perseverance at length crowned all his efforts, and the clergyman attained the height of his wishes, and became the first frame-work knitter.

The subsequent history of Lee is a pathetic record of struggles and injustice. When, after a long course of arduous experiments, he had succeeded in his object of knitting by machinery, he looked for the golden harvest which had flattered his imagination, as now very surely within his grasp. But on applying to the Crown for a patent he was absurdly refused it, on the ground that it would interfere with the means of subsistence of a great many poor persons to whom knitting by hand gave employment. Queen Elizabeth is said to have observed, by way of softening the refusal, "Had Mr. Lee made a machine that would have made *silk* stockings, I should, I think, have been justified in granting him a patent for that monopoly, which would have affected only a small number of my subjects; but to enjoy the exclusive privilege of making stockings for the whole of my subjects is too important to grant to any individual." Such were the erroneous notions of political economy prevalent at that period, even among those accounted as the wisest of their time. Although much

cast down at this, Lee did not abandon himself to despair. Confiding in the Queen's words, that if he could only knit silk hose by his machine, he should have the patent, he now applied his mechanical ingenuity to a new object, and he obtained some encouragement from Henry Carey, Lord Hunsdon, a nephew of Anne Boleyn, and therefore a cousin of the Queen, who, in consideration of a share in the expected patent, not only engaged to advance funds, but probably to secure his interest, actually bound his son and heir, Sir William Carey, an apprentice to Lee; and thus, says the Nottingham mechanic, "the first framework stocking-maker's apprentice was a knight, and eldest son to a lord who was of the blood royal."

Lee's original stocking-frame had but eight needles to the inch, and was equal only to the production of worsted hose of the very coarsest sort. With even twice that number of needles silk hose could not be made by it of less weight than half a pound per pair, and what are called twenty-four gauge silk frames, having twenty-four needles in an inch, are now probably the coarsest silk frames used in England; but nothing daunted, Lee, with the help of his brother James, set to work to improve his invention with marvellous perseverance. After an experience of more than two centuries the finest frames made in the "insides" as they are termed, having "jacks" and "combs," contain sixty-four jacks in three inches. Lee, with the help of his brother James, attempted at once to make a frame having sixty in three inches, and that without "sleys," which was a later invention. His combs and "counters" were not cast, but wedged in, and his needles were soldered into

brass combs instead of being cast into pewter, as now practised. At length, having surmounted all obstacles, about the year 1595 he completed the making of plain silk stockings from what is called a "twenty gauge silk frame," having only "jacks," without "lead sinkers," an invention which might have excited wonder and admiration even in these days.

With the assistance of his noble patron Lee erected and set to work nine frames of this description; but the Queen was obstinately determined not to grant the patent, and the unfortunate inventor had no hope of securing the due reward of his toil unless he could keep the secret of his machine, which he took extraordinary pains to do. His apprentices and workmen were principally composed of his own relatives, who thought it so high an honour to belong to the new craft that they wore their working-needles with ornamental silver shafts suspended from a silver chain at their breasts—a mark of distinction which was preserved as late as the reign of Queen Anne; but for all this Lee reaped nothing but disappointment from his efforts; for scarcely had his nine frames been erected when, in 1596, his great supporter, Lord Hunsdon, died: as also, about the same time, the young lord who had been apprenticed to him. Reduced to despair, and it is said, almost to want, Lee determined to quit the country which had treated him so ungratefully; and in 1603 eagerly accepted an offer of the celebrated Sully, then ambassador from France, to remove with his brother and his workmen to Rouen. After several years' delay in setting up his frames in Rouen, Lee went to Paris to make more extensive arrangements with the Government; but here his evil

genius again awaited him. Sully had brought over the English inventor and his men, contrary to his own inclinations and entirely in deference to the avowed wish of the wise King Henry IV., to introduce the silk manufactures into France; but scarcely had Lee arrived in Paris when the King was assassinated by Ravaillac; and thus the poor inventor's brilliant expectations were again at an end. His fortitude now forsook him, and he gave way to melancholy; he thought himself the most unfortunate of men. Alone, unprotected, in a foreign country, after twenty-two years' struggles, he sickened at the thought, and sent for his brother James from Rouen; but before he arrived the inventor of the stocking-frame died of a broken heart in the midst of strangers. This happened in the year 1610, the very year of the king's assassination.

After Lee's death his brother James and six more of the little band of artificers who had emigrated from England returned home, leaving two of their companions behind. It has been said that but for this, the valuable art might have been lost to this country; but there was one individual who knew the secret as well as any of them, who had declined to accompany them into their voluntary exile. This was a miller, named Aston, who lived at Thoroton, in Nottinghamshire—a man to whom the stocking-frame was subsequently indebted for many valuable improvements which ultimately gave rise to an extensive manufacture of stockings in England, not only for this country but for foreign nations.

A curious old painting, relating to Lee's story, originally belonged to the Stocking Weavers' Company, and was hung up in their hall. It represented a man

in a student's dress pointing to a stocking-frame, and addressing a woman who is engaged in knitting by the hand—the only process previously known. The original picture has long been lost, and is now known only through the medium of an engraving. According to the compiler of the catalogue of portraits in the Patent Museum, it bore the inscription, "In the year 1589 the ingenious William Lee, A.M., of St. John's College, Cambridge, devised this profitable art for stockings, but being despised went to France; yet of iron to himself, but to us and to others of gold, in memory of whom this is here painted."

WILLIAM HYDE WOLLASTON, THE ECCENTRIC DISCOVERER.

The well-known natural philosopher, Dr. Wollaston, was a man of singular habits. He was accustomed to carry on his experiments with very few instruments, and in the strictest seclusion. Even his most intimate friends were never permitted to enter his place of study. Dr. Paris relates that a foreign philosopher once called on Wollaston with a letter of introduction, and, unaware of the philosopher's peculiarity, expressed an anxious desire to see his laboratory. "Certainly," was the reply; and the misanthropic doctor immediately produced a small tray containing some glass tubes, a simple blowpipe or bent metal tube, worth a few pence only, two or

three common watch-glasses, a slip of platinum, and a few similar things.

It is also related that shortly after Wollaston had inspected a grand galvanic battery constructed by Mr. Children, he met a brother philosopher in the street. Seizing his button (which was, it appears, his constant habit when speaking of any subject of interest) he led the friend into a secluded corner, where, after looking carefully about him as if engaged in some strange mystery, he took from his pocket a tailor's thimble which contained a galvanic arrangement, and pouring into it the contents of a small phial, he instantly heated a platinum wire to a white heat.

This eccentric philosopher was born at East Dereham, in Norfolk, in 1766, and was the son of Francis Wollaston, a man of some eminence as an astronomer, who published a catalogue of the northern circumpolar stars. Dr. Wollaston was educated as a physician, and shortly after he came to London became a candidate for the office of physician to St. George's Hospital. Being defeated in this contest it is said that he declared in a moment of pique that "he would abandon the profession, and never more write a prescription." It is certain that he subsequently gave up the profession to devote himself entirely to experimental sciences. His name is connected with chemical discoveries of the highest importance. In 1804 and 1805 he made known palladium and rhodium, two new metals contained in the ore of platinum, and associated with osmium and iridium, discovered about the same time by Mr. Tennant. In 1809 he showed that the supposed new metal tantalum was identical with columbium, previously dis-

covered by Mr. Hatchett; and shortly before his death he transmitted to the Royal Society a description of his ingenious method of rendering platinum malleable, by which invention he is stated to have acquired more than thirty thousand pounds. He contrived a simple apparatus for ascertaining the power of bodies to refract light. His camera lucida furnished persons ignorant of drawing with an easy method of delineating natural objects. His periscopic glasses were found in every optician's shop, as well as his sliding rule for chemical equivalents, which made it easy in a moment to calculate the proportions of one substance necessary to decompose a given weight of another. Dr. Wollaston was also the first to demonstrate the identity of galvanism and common electricity, and the cause of the different phenomena exhibited by those principles.

Wollaston had a great objection to his portrait being taken, though there is one fine portrait, by Jackson, of the eccentric philosopher in the meeting-room of the Royal Society, the history of which is interesting. His family and friends knew his reluctance on this point; nevertheless Mrs. Somerville, the well-known authoress, who earnestly wished to possess a portrait of her friend, Dr. Wollaston, many times asked when he would sit for his picture, to which he had invariably answered, "Never." One day, however, when he was greeted with the same question, he said, "It is evident that I must either forego the pleasure of coming to this house or submit; so I will submit." He added, "Let us separately write the name of the artist to be employed." This was agreed; and it turned out that both parties had named the same artist.

William Hyde Wollaston died on the 22nd of December, 1828, aged sixty-two. When he was nearly in the last agonies, from an extensive cerebral disease, some friend near observed, in a whisper, that he was not conscious of what was passing around him. The dying man, however, caught the words and motioned for a pencil and paper to write. When he returned them it was found that he had written down some rows of figures, forming a sum in addition, which he had cast up correctly.

OLD PREJUDICES AGAINST COTTON SPINNING.

While so enormous a number of our working population look eagerly to the question of supplies of cotton, it is difficult to imagine the fact that, one hundred and thirty years since, the newly-introduced cotton fibre was popularly regarded as about to cause the ruin of Great Britain. Even the Legislature shared this belief, and actually passed an Act of Parliament in 1721 imposing a penalty of five pounds upon the weaver, and twenty pounds upon the seller of a piece of calico; and long after that date it was the fashion to attribute any special distress falling on the working-classes to this cause. Even criminals on the scaffold confidently appealed to the prejudice of the spectators, and assumed a high moral tone on this point, as appears from the following singular letter from "Cork, in Ireland," which appears under the date of May 3 in the "Gentleman's Monthly Intelligencer" for 1734:—

"This day one Michael Carmody was executed here for felony; upon which the journeyman weavers of this city (who labour under great difficulties by reason of the deadness of trade, occasioned by the pernicious practice of wearing cottons), assembled in a body, and dressed the criminal, hangman, and gallows in cottons, in order to discourage the wearing thereof; and at the place of execution the criminal made the following remarkable speech:—

"'Give ear, O good people, to the words of a dying sinner. I confess I have been guilty of many crimes that necessity compelled me to commit, which starving condition I was in, I am well assured, was occasioned by the scarcity of money, that has proceeded from the great discouragement of our woollen manufactures.

"'Therefore, good Christians, consider, that if you go on to suppress your own goods by wearing such cottons as I am now clothed in, you will bring your country into misery, which will consequently swarm with such unhappy malefactors as your present object is; and the blood of every miserable felon that will hang, after this warning from the gallows, will lie at your doors.

"'And if you have any regard for the prayers of an expiring mortal, I beg you will not buy of the hangman the cotton garments that now adorn the gallows, because I can't rest quiet in my grave if *I should see* the very things wore that brought me to misery, thievery, and this untimely end; all which I pray of the gentry to hinder their children and servants for their own characters' sake, though they have no tenderness for their country, because none will hereafter

wear cottons, but oyster-women, criminals, hucksters, and common hangmen.' "

The pernicious practice of wearing cottons has, happily for England, continued to extend itself in spite of Michael Carmody's bitter denunciations. Nearly thirty years afterwards, on the accession of George III., the value of all the cottons manufactured annually in England was estimated at £200,000. In 1860, the value of the cotton fabrics issuing from English looms was upwards of fifty-two millions sterling. It was the introduction of steam as the motive power of the spindles that gave the rapid extension of production and commerce which has distinguished the last half century. In 1823, Great Britain employed ten thousand steam-looms; the number at present in operation is nearly four hundred thousand, driven by a power of 294,000 horses, and directly employing nearly half a million of workpeople.

THE PHILOSOPHER TAUGHT BY THE CHILD.

The first scientific discovery made by Sir Humphrey Davy was due entirely to the observation of a little child. When a youth and eagerly curious on all phenomena connected with his favourite study, he was appealed to by this child to know why it was that when two pieces of bonnet-cane were rubbed together a little faint light came from them? If the fact had

ever been observed before it was at least new to the chemist's apprentice. Patting his little questioner on the head, he replied, "I do not know. Let us see if it is so; and then we will try and find out why." Experiment showed that the child had correctly observed the fact. The young philosopher pondered upon it, and perceived that the principle which it indicated must be of much wider application; and the train of inquiry which this set in motion gradually brought him to the discovery of the siliceous earth in the epidermis, or skin of canes, reeds, and grasses.

With respect to this beautiful discovery, Davy observes in his "Agricultural Lectures," that this epidermis serves as a support, protects the bark from the action of insects, and seems to fulfil a part in the economy of these feeble vegetable tubes similar to that performed in the animal kingdom by the shells of the crustaceous insects.

HERSCHEL'S FIRST AND LAST TELESCOPES.

It is well known that William Herschel was in early life an organist at a chapel at Bath. He had to play incessantly either at the oratorios, or in the rooms at the baths, at the theatre, and in the public concerts, and he could not refuse the numerous pupils who wished to be instructed in his school. Nevertheless, he

found time to study mathematics, which, in their turn, led him to optics. At length, a simple telescope, only two feet in length, fell into his hands. This instrument (says M. Arago, in his brilliant sketch of this great astronomer, which we abridge for the benefit of our readers) showed him, however imperfect, a multitude of stars that the naked eye cannot discern; showed also some of the familiar constellations, but now under different aspects, and revealed to him forms that even the richest imaginations of antiquity had never suspected. He was filled with enthusiasm, and determined to have one of larger dimensions. But when the answer from London arrived, the price which the optician demanded proved to be far beyond the pecuniary resources of a mere organist. This unexpected difficulty, however, only inspired him with fresh energy. He could not buy a telescope, but he was determined to construct one with his own hands; and, after a multitude of experiments, perseverance at last received its reward.

It was in the year 1774 that Herschel had the happiness of being able to examine the heavens with a Newtonian telescope of five feet focus, entirely of his own construction. This success tempted him to undertake still more difficult tasks. Other telescopes of seven, of eight, of ten, and even twenty feet focal distance, crowned his efforts. Nature granted to the astronomical musician the unheard-of honour of commencing his career of observation with the discovery of a new planet, situated on the confines of our solar system, and now known by the name of Uranus. Dating from that moment, Herschel's reputation, no

longer in his character of musician, but as a constructor of telescopes, and as an astronomer, spread throughout the world.

Herschel was a native of Hanover, and George III., much inclined to protect and patronize both men and things of Hanoverian origin, had Herschel presented to him. He was charmed with the simple yet lucid and modest account that he gave of his repeated endeavours; ensured to him a pension of three hundred guineas a year, and, moreover, a residence near Windsor, first at Clay Hall, and then at the subsequently famous observatory at Slough. The hopes of the king were completely realized. The little house and garden of Slough became the spot of all the world where the greatest number of discoveries have been made. "The name of that village," says Herschel's enthusiastic biographer, "will never perish; science will transmit it religiously to our latest posterity."

Miss Caroline Lucretia Herschel went to England as soon as her brother became special astronomer to the king. She received the appellation there of assistant astronomer, with a moderate salary. From that moment she unreservedly devoted herself to the service of her brother, happy in contributing night and day to his rapidly increasing scientific reputation. Caroline Herschel shared in all the night-watches of her brother, with her eye constantly on the clock, and the pencil in her hand. She made all his calculations, made three or four copies of all the observations in separate registers, co-ordinated, classed, and analysed them. If the scientific world saw with astonishment how Herschel's works succeeded each other with unexampled rapidity during so many years, they

were specially indebted for it to the ardour of this lady. Astronomy, moreover, has been directly enriched by the knowledge of several comets through her labours. After the death of her illustrious brother, Miss Herschel retired to Hanover, to the house of John D. Herschel, a musician of high reputation, and the only surviving brother of the astronomer. For some years Herschel enjoyed with delight the distinguished success of his only son, Sir John Herschel. At his last hour he sunk to rest with the pleasing conviction that this beloved son, heir of a great name, would not allow it to fall into oblivion, but adorn it with fresh lustre, and that great discoveries would honour his career also. No expectation of the illustrious astronomer has been more completely verified.

Our scientific journals gave some years since an account of the means adopted by the family of Herschel for preserving the remains of the great telescope constructed by the celebrated astronomer. The metal tube of the instrument, carrying at one end the recently-cleaned mirror of four feet ten inches in diameter, was placed horizontally in the meridian line, on solid piers of masonry, in the midst of the circle, where formerly stood the mechanism requisite for manœuvring the telescope. On the 1st of January, 1840, Sir John Herschel, his wife, their children, seven in number, and some old family servants, assembled at Slough. Exactly at noon the party walked several times in procession round the instrument; they then entered the tube of the telescope, seated themselves on benches that had been prepared for the purpose, and sang a requiem, with English words, composed by Sir

John Herschel himself. After their exit, the illustrious family ranged themselves round the great tube, the opening of which was then hermetically sealed. The day concluded with a party of intimate friends.

FIVE GUINEAS FOR A NEW PLANET.

The elder Herschel was a man of kindly disposition; but like most persons who have risen out of early difficulties, he was extremely careful of money, and became wealthy. A traditional anecdote of his domestic life, however, shows that he could be good-humouredly generous on occasions. An old servant, named Betty, was with him at the time of constructing his telescope, and his first act on discovering the planet Uranus was to give her a guinea, adding, "You shall have five guineas, Betty, when I discover another." The poor woman accepted the promise in all seriousness, and great was her interest in all her master's subsequent labours. Planets, however, even by a Herschel, are not to be discovered every day, and Betty's hopes were long deferred. One day Herschel received a friend to whom he had previously told this story, with the exclamation, "I have paid my five guineas!" "What!" exclaimed the friend; "have we to rejoice over another great discovery?" "No," replied the astronomer, with a good-humoured smile; "I have simply paid poor Betty in

advance. You see," he added, as his visitor appeared puzzled, "I often pursue these researches long after the good woman has retired to rest. How is Betty to know that I do not discover new planets clandestinely, and keep her from the knowledge with a mean determination to save my money? Better to pay at once; better to pay at once."

THE FATES OF JOHN KAY AND LEWIS PAUL.

The lives of our early inventors form almost one unbroken tale of persecution and disappointment. This is particularly exemplified in the stories of John Kay and Lewis Paul. From the earliest ages the loom had remained without improvement, and the spinners and weavers at the beginning of the last century used practically the same machines as were employed by the Egyptians for the manufacture of those linen cloths, of which we have still specimens wrapped round the bodies of the mummies in the British Museum; when in 1735 Kay, the son of a woollen manufacturer at Bury, in Lancashire, produced the fly shuttle, thereby at once reducing the labour of weaving by more than one half. Kay was a well-educated man, and had been on the Continent, on his return whence he settled at Colchester, and there conducted a woollen manufactory; but the weavers of that place rose against him and drove him from the town. He then, in 1738, established himself as an en-

gineer at Leeds. Here, however, he was still more unfortunate; for although the clothiers of Yorkshire were not unwilling to adopt the fly shuttle, they refused to pay for its use, and he was driven to the Court of Chancery to protect his rights. The manufacturers formed an association to oppose his claims, which they impudently denominated The Shuttle Club, the avowed purpose of which was to defraud him of his just remuneration. The workmen, too, rose against him, and by their violence compelled him to close the workshops. Once more a wanderer, he settled at his native place at Bury; but here, in 1753, a lawless and ignorant mob broke into his house, destroying everything they found, and would have killed him if he had not been conveyed to a place of safety by two friends, wrapped in a wool sheet. A few years later, having in vain sought assistance from the Society of Arts, he fled in disgust to France, where, however, he was encouraged by the British Ambassador to return to England in the hope of some reward from our Government, for the immense benefits which his inventions had bestowed on his countrymen. Disappointment was again his portion. Baffled on all sides and hopelessly crushed in spirit, the unfortunate "reed-maker," as he styled himself, returned to Paris, where he died in poverty and obscurity—no stone telling where he lies. His daughter, the companion of his misfortunes and the solace of his last days, was afterwards compelled to take refuge in a nunnery.

Bury, says Mr. Bennet Woodcroft, has produced two great men—John Kay, the inventor, and Sir Robert Peel, the statesman. To the latter, the inhabitants have already erected a statue; to the former they have

still to do that act of justice. Kay's improvements in machinery for weaving continue in use up to the present time in tens of thousands of looms in this kingdom for making cloths of silk, cotton, linen, and woollen.

Lewis Paul's history, though less tragic, was scarcely less marked by misfortune. His name is almost forgotten, and the glory of his ideas absorbed in the more successful modifications of the more fortunate Arkwright. At the very time when the mob were driving Kay out of Colchester, Lewis Paul patented a machine which superseded the ancient hand-wheel for spinning, and adopted the method of spinning by the aid of rollers. He was the son of a Dr. Paul, a man of some eminence; but almost all that is known of his history is derived from two letters, still extant, addressed by him to the Earl of Shaftesbury, under the guardianship of whose father he appears to have been placed in early life. He confesses that he made but an ill use of his fortune; but says, that before the calamities of which he had laid the foundation had reached him, he had exerted himself to repair his affairs with such ardour and success that "notwithstanding the impediments necessarily in the way of a person who had spent his time, in every circumstance, so remote from the arts of trade, he nevertheless completed a machine of great value in one of the most extensive manufactories of the kingdom;" and he adds, that "in something more than the course of twenty years it gained him £20,000 as patentee." He complains of cabals and enemies, and of rivalry of manufacturers, to which he attributes his subsequent misfortunes. The first patent for spinning granted to Paul was dated 24th June, 1738, and was for fourteen years. It expired in 1752, and,

singularly enough, it does not appear that any works were afterwards carried on under it.

Dr. Johnson was intimately acquainted with Paul, and befriended him in various ways. A great number of letters between them have been published, and in one preserved in the Patent-office, Johnson suggests to him a mode of obtaining money from Mr. Cave, the printer of the "Gentleman's Magazine," to carry on his spinning experiments. The specification of his first patent explains that when the cotton or wool is prepared, "one end of the sliver is put between a pair of rollers, or cylinders, or some such movement, which, being turned round by their motion, draws in the raw mass of cotton to be spun in proportion to the velocity given to the rollers. As the cotton (it adds) passes regularly through or betwixt these rollers, a succession of other rollers, moving proportionally faster than the first, draw the sliver into any degree of fineness that may be desired." The poet Dyer, the author of "Grongar Hill," in his poem of the "Fleece," in 1757, described the same operation with more nicety of detail than poetic fire, as follows:—

"A circular machine, of new design,
In conic shape; it draws and spins a thread
Without the tedious toil of needless hands.
A wheel, invisible, beneath the floor,
To ev'ry member of th' harmonious frame
Gives necessary motion. One, intent,
O'erlooks the work; the carded wool, he says,
Is smoothly lapp'd around those cylinders,
Which, gently turning, yield it to yon cirque
Of upright spindles, which, with rapid whirl,
Spin out in long extent, an even twine."

This might well pass for a description of a spinning-machine of these days; but the fact that after being extensively adopted it fell into total disuse, clearly shows that Arkwright's machine must have been so much superior as to entitle it to be considered original. Lewis Paul died in 1759, at Brook Green, Kennington, and was buried at Paddington.

A TROUBLESOME PERSON IN CHEMISTRY.

A WRITER in the "North British Review," tells an amusing story, illustrative of the unwillingness to receive new truths which is characteristic of some minds. Long after Sir Humphrey Davy had become famous in London circles as the "young chemist," who attracted larger audiences to his lectures at the Royal Institution than perhaps any purely scientific man had ever done before, there was a certain professor of chemistry in the college at Aberdeen who systematically passed over his discoveries. Some bolder spirits among the Doctor's colleagues at length aroused his attention to the subject; and the Professor was compelled to take notice at last of Davy's great discovery of potassium. Accordingly at his next lecture he began by saying, "Gentlemen,—Both potash and soda are now said to be metallic oxides—the oxides, in fact, of two metals, called potassium and sodium, by the discoverer of them—one, Davy, in London, a verra troublesome person in chemistry."

"PARSLEY" PEEL.

THE founder of the Peel family and the father of the first baronet, kept a skilled mechanic in his cotton-printing establishment, for the purpose of carrying out his ideas in the improvement of machinery. This man, we are told by Sir Lawrence Peel, was kept concealed in the private house of a Mr. Haworth at Brookside, near Blackburn, where he worked in secret, as if he was engaged in some mysterious wickedness. In the course of his experiments Mr. Peel also introduced some improvements in the printing of the cottons; in connection with which a story is still current in the Peel family. This ingenious manufacturer was in his kitchen one day, making some experiments in printing on handkerchiefs, and other small pieces, when his only daughter, then a girl, afterwards Mrs. Willock, the mother of the postmaster of Manchester, brought him in from their garden of herbs a sprig of parsley. It was some proof of taste in so young a girl (says Sir Lawrence) that she could discern beauty in a common pot herb, which is generally regarded as created only for a garnish or a fry. She pointed out and praised the beauty of the leaf, and looking, by the habit of the remarkable family to which she belonged, naturally to the useful side, she said that she thought it would make a very pretty pattern. Her father took it from her hand, looked at it attentively, praised her for her taste, and said that he would make a trial of it. She, delighted not to be pooh-poohed as discoverers among young folks often are, lent her aid with all the

alacrity of a girl of fourteen. A pewter dinner-plate—for such was then the common dinner-plate of families of their degree—was taken down from the shelf, and on it was sketched, or scratched, a figure of the leaf, and from this impressions were taken. This was called in the family, "Nancy's pattern," after the little girl who invented it. It became one of the most popular patterns in cotton cloth ever designed, and was at one period as widely known and as universally used as the "Willow pattern" in crockery ware. It may be said that it had no small share in laying the foundation of the fortunes of the Peel family. In the trade it was everywhere spoken of as the Parsley leaf pattern, and alliteration lending its aid, the fortunate father of the shrewd young lady became generally known by the nickname of "Parsley Peel."

THE EARLIEST UMBRELLA.

It is generally stated that Jonas Hanway, the well-known philanthropist, was the first man who carried an umbrella in the streets of London. Hanway died in 1785. Early in the century a large umbrella was kept in the halls of aristocratic mansions for the special protection of the lady of the house in passing from her door to her coach; and it was not uncommon to keep such articles in the coffee houses or taverns for the benefit of customers as early as Queen Anne's reign. The fact, however, is not the less true, that it is only

within the lifetime of persons now living that this almost indispensable protection from the moist climate of England has become generally adopted. In the "Female Tatler" of December 12, 1709, appears a satirical notice informing the "young gentleman belonging to the custom-house who, for fear of rain, borrowed the umbrella at Will's coffee-house, in Cornhill, of the mistress," that "to be dry from head to foot on the like occasion he shall be welcome to the maid's pattens." Gay mentions the umbrella as early as 1712, in his poem of "Trivia," in which he describes the "tucked-up sempstress" walking in a shower while streams "run down her oiled umbrella's sides." Mr. J. Jamieson, a Scottish surgeon, brought with him from Paris in 1781, or 1782, an umbrella which was the first seen in Glasgow where he resided, and where it attracted universal attention.

The earliest specimens of the English umbrella were made, as mentioned in Gay's lines, of oiled silk, which, when wet, was exceedingly difficult to open or close. The stick and furniture were heavy and inconvenient, and the article very expensive. Its transition to the present portable form is due, partly to the substitution of silk and gingham for the heavy and troublesome oiled silk, which admits of the ribs and stretchers being made much lighter; and also to the many ingenious mechanical improvements in the framework which have been made from time to time, chiefly by English and French manufacturers, several of which have been patented. No change has proved a greater convenience than that from the old-fashioned ring and string, for securing the umbrella when closed, to the simple clip and

india rubber braid now in use; and yet, before this was accomplished, many transitions had to be passed through.

Though the umbrella is itself of older date, there is nothing to invalidate the story that it is to the good Jonas Hanway that we are indebted for the valuable example of moral courage in first carrying an umbrella in the streets of London. It is difficult now to conceive the amount of persecution which this strange proceeding entailed upon the unfortunate philanthropist, whose object was, doubtless, less the protection of his own person than that of showing his fellow-countrymen how they might avoid those continual drenchings to which they had so long submitted. The hackney coachman and the sedan chairman were the first to call out against the threatened innovation, declaring that they were ruined if it came into fashion. When they began to be carried, even a gentleman accompanied by a lady, under the shelter of the new-fangled rain protector, were hooted as they passed along; while a gentleman alone, carrying one, was certain to be attacked with cries of "Frenchman! Frenchman! why don't you call a coach?" and other more offensive salutations.

THE OLD TELEGRAPHS.

Among the still primitive people of Montenegro a plan of transmitting information prevails which may be considered the rudest system of telegraphy still existing. When a shepherd in the mountains finds himself in want of society, he sends out at random a peculiar kind of yell with a view of attracting the attention of any one similarly situated who may chance to be within hearing upon some other mountain side, and may also feel a desire for conversation. It is well known at what a great distance shrill sounds may be distinctly heard in these mountainous regions. The unseen friend, whose ears have caught the sound, responds in the same way, and then begins a dialogue about their flocks and herds, or any other country gossip; and should there chance to be news of public interest, such as of any important person or foreigner passing that way, the receiver of the intelligence shouts it out in the open air for the benefit of the mountain nearest to him, and so it passes from one to another through a considerable part of the country. "This practice of calling from hill to hill," says a recent traveller, "also answers the purpose of an advertisement in a newspaper, and that with wonderful celerity. At any given time one half of this badly-housed population may mostly be found in the open air, and their ears are astonishingly quick at catching these sounds. Any one who yells out his requirements may generally calculate on some one who has nothing else to do repeating them for him to the next living

telegraph. An acquaintance told me he was once in want of a mule that was at the time grazing in the mountains more than ten miles off. He accordingly began the hue and cry. 'Ho! ho! you people there in the village of Brelizzu! High up in the mountains of Glenbotich, by the great beech tree with the withered boughs, my little lad Yonko is keeping my white-footed mule. Let him know that he is to come with it down to the road as fast as he can.' Thus the owner of the mule yelled at random into the air, and immediately some living echo took up his words, repeating them exactly; and so the message went till it reached the boy, and the owner of the mule found it waiting for him at the appointed place."

Beacon fires were the ancient mode of telegraphy adopted in Great Britain, and in an act of the Scottish Parliament of 1455, it is directed that "one bale or faggot shall be warning of the approach of the English in any manner, two bales that they are *coming indeed*, and four bales blazing beside each other, that the enemy are in great force." The famous Bishop Wilkins, who pretended to discover the art of flying, describes certain alphabetic systems of transmitting information which depended merely upon the number and alternate display or concealment of lights. The Marquis of Worcester, in 1663, described a system by which, as he said, a man at a window, as far as the eye could discover black and white, could hold discourse with his correspondent; and the ingenious Dr. Hook, in 1684, explained to a meeting of the Royal Society a scheme for communicating one's mind at distances of thirty, forty, a hundred, or a hundred and twenty miles "in as short a time

almost as a man can write what he would have sent." His plan required the use of the telescope, and was of course dependent on weather and various accidents; but this was the germ of the old semaphore which was actually used by our Government, and was at work in this country as late as 1852 between Liverpool and Holyhead. About twenty years after Hook's scheme was unfolded, an inventor, named Amontous, brought forward a similar plan in France. Persons were placed by him in several stations at a certain distance from one another, and by the help of a telescope a man in one station was enabled to see a signal in the next before him. He was then required immediately to make the same signal, so that it might be seen by persons in the station after him. The signals used were either large letters of the alphabet or figures of various shapes to represent them. Amontous publicly demonstrated the practicability of his plan; but no system of signals was applied to any useful purpose till the period of the French Revolution. The telegraph then brought into use, in either 1793 or 1794, was the invention of M. Chappé, and, though similar in principle to the machine invented by Hook, it was greatly superior. The roof of the Louvre was his telegraphic terminus, and Chappé, having received from the Revolutionary Government a message to be forwarded to the army at Lille, he gave an understood signal to the heights of Montmartre, which was the second station, to prepare. At each station there was a watch-tower where telescopes were fixed, and the person on watch gave the signal of preparation throughout the line. The watcher at Montmartre then received, letter by

letter, the sentence from the Louvre, which he repeated by his own machinery, and this was again repeated from the next height with as much rapidity as possible, until the message arrived at Lille. The upright post which was erected on the Louvre had at the top two transverse arms, moveable in any direction by a single piece of mechanism. Chappé invented a number of positions for these arms, which stood as signs for the letters of the alphabet, and even these were reduced as much as possible. The signs too were arbitrary, so that they could be changed every week, all that was necessary being that the persons at each terminus should have the key. Two working models of this instrument were made at Frankfort, and sent by Mr. W. Playfair to the Duke of York, and thus the plan and the alphabet of the instrument came to England. Chappé was not more fortunate than other inventors in escaping opposition and discouragement. The people were prejudiced against the new machinery. His first instrument and station were destroyed by the populace; his second was burned to the ground, the unfortunate inventor narrowly escaping from the mob with his life; but the telegraph was subsequently taken up by the French Government, and became extensively used on the Continent.

This kind of telegraph, known as the aerial, was first established in England seventy years ago, a line of stations being formed from the Admiralty at Whitehall to the sea-coast, and information was thus conveyed from London to Dover in ten minutes. The expense of working and mounting the line from London to Portsmouth was three thousand three hundred pounds per

annum. Though of great service to the Government, this old cumbrous system was of course only available in clear weather. Vexatious interruptions continually took place, and droll accidents occasionally resulted from the sudden cessation of communication, from a fog or similar cause, during the transmission of a message. When the British army were fighting under Wellington in Spain, news were anxiously expected from that great commander through the Admiralty signals. The public were in a state of feverish excitement, when one day the disastrous message was received, "Wellington defeated." The funds were violently agitated, the people and the Government were bewildered, and terrible rumours of enormous slaughter and great loss of guns, colours, and ammunition were heard on all sides. It turned out, however, that, just as the word "defeated" had been deciphered at some part of the line, a sudden mist had come on and cut off the remainder of the message. When this inopportune visitor had passed away, the public mind was instantly relieved with the news that the message was not "Wellington defeated," but "Wellington defeated the French."

THE HISTORY OF MATCHES.

Before the year 1820, scarcely any other method of producing fire was known than that of the old flint, steel, and tinder-box; that once familiar trio which can scarcely yet be said to be entirely out of use in England. As early as the middle of the seventeenth century, however, the discovery of phosphorus had indicated a more certain means of procuring light or fire, and in 1677 Daniel Krafft, a famous German chemist, exhibited in England some striking effects produced by this new agency. It is believed that some trial was made as to whether an ordinary match could be ignited by its agency; but it is remarkable that the philosopher Boyle, described it only as "a factitious, self-shining substance," procured but in very small quantities, and with great labour and time, the principal value of which was to supply a light in the night, or in dark places when exhibited in glass vessels. It was about forty years ago, that a German, named Doebereiner, made the curious discovery that thinly divided or "spongy" platinum will inflame a mixture of hydrogen gas and atmospheric air, and hence invented his instantaneous light apparatus, first known by the name of the hydrogen lamp. This was greatly admired at the time, and is even now frequently employed; it having been applied to light an ordinary gas burner, required to be lighted at intervals during the day time, for the purpose of sealing parcels.

About the same period, several methods of obtaining light by means of phosphorus were proposed; but they

were generally more ingenious than practical. In one case equal quantities of phosphorus and sulphur were fused together in a glass tube, which was subsequently closed with a cork. On opening the tube, if a splinter of wood was dipped into the mass, so that a small quantity of the composition adhered to it, it became ignited when slightly rubbed on the cork used to close the phial. This apparatus soon became entirely obsolete.

The first great practical improvement in the means of obtaining light consisted in covering the end of a match which had previously been dipped in sulphur, with a mixture of sugar and chlorate of potash, which being steeped in sulphuric acid communicated the inflammation to the underlying coating of sulphur. These matches we believe to have been introduced from France; but before this, Captain Manby, feeling the necessity of being able to obtain an instantaneous light for the firing of his well-known rocket for conveying a rope to a stranded ship, had been accustomed to employ a similar mixture. The same principle was involved in the manufacture of the so-called "Promethean" matches, invented by Mr. Jones of the Strand. These matches were made of a roll of paper, in one end of which was placed a portion of the mixture above described, with a small tube hermetically sealed, similar to those in which the leads of ever-pointed pencils are preserved, and containing a minute quantity of strong sulphuric acid. By pinching the end of the match with a small pair of pliers sold for the purpose, the tube was crushed, and the sulphuric acid came in contact with the mixture and ignited it. These matches, though convenient, were very expensive; and the popular thin wooden box of matches,

now so familiar, and sold for a halfpenny, was still undreamed of. The first true friction matches, known as lucifers (a Latin word, signifying "light bringers"), were coated with a mixture of sulphide of antimony and chloride of potash, made into a paste with gum-water, and were lighted by drawing them rapidly between the two surfaces of a square piece of folding sand paper. From this somewhat cumbrous and inconvenient device, the public were finally relieved about the year 1834, when the present "Congreve" match was introduced nearly simultaneously in various countries. The secret of these was the substitution of Boyle's "factitious shining" substance—phosphorus—for sulphide of antimony; but to whom the credit of this useful idea is due does not appear. On the Continent the progress in adopting the match was very slow, its use having been positively prohibited in various countries, on account of the assumed danger of fire; but in England the cheapness to which it was speedily reduced, soon drove out, not only the old tinder box, but even the really useful lucifer match.

DAVY AND THE "LAUGHING GAS."

The dangers which enthusiastic men of science will voluntarily undergo for the sake of testing new principles have never been more strikingly exemplified than in the history of Sir Humphrey Davy's early experi-

ments on the effect of nitrous oxide, popularly known as "laughing gas." Davy began his chemical studies in March 1798, when a youth of eighteen, and only two years later appeared his "Researches," which immediately gave him high rank, not as a mere chemist, but as an original discoverer. Herein, for the first time, the properties of nitrous oxide and the wonderful effects of that gas in respiration were disclosed to the astonishment of the public. Hitherto it had been regarded among natural philosophers with a sort of vague horror, and from its deadly effects upon small animals it was suspected that it was the very principle of the plague itself, that terrible visitation which, from time to time, swept over Europe. Nothing daunted by this, the young philosopher boldly resolved to try its effects upon his own system. He could not have been ignorant of the terrors of Spallanzani's experiments upon the gastric juice, and only a short time before the brave Pelletier, the French chemist, had lost his life in the attempt to breathe another kind of poisonous gas. But the boy philosopher thought it necessary to compare the effects of nitrous oxide with those of common stimulants, and he was resolved to pluck knowledge out of this dangerous trial. With this view, he shut himself up, and first submitted himself to intoxication so extreme as to produce distressing and even alarming symptoms. To ascertain the effects of an atmosphere containing large quantities of the same gas, he enclosed himself in a box, and at three successive intervals, for an hour and a quarter (during which time he remained in the box), had sixty quarts of the gas thrown in, finally constituting a large proportion of the air which

he was breathing. When the last twenty quarts were thrown in his emotions became similar to those produced by a moderate dose of the pure gas; but, not satisfied with this, immediately after coming out of his cage, he began to breathe in twenty quarts of nitrous oxide, probably the most effectual trial ever made of this wonderful agent.

"A thrilling" (he observes, in his own account of this audacious experiment), "extending from the chest to the extremities, was almost immediately produced. I felt a sense of tangible extension highly pleasureable in every limb; my visible impressions were dazzling and apparently magnified; I heard distinctly every sound in the room, and was perfectly aware of my situation. By degrees, as the pleasureable sensations increased, I lost all connection with external things; trains of vivid, visible images rapidly passed through my mind, and were connected with words in such a manner as to produce perceptions perfectly novel. I existed in a world of newly-connected and newly-modified ideas. I theorized; I imagined that I made discoveries. When I was awakened from this semi-delirious trance by Dr. Kinglake, who took the bag from my mouth, indignation and pride were the first feelings produced by the sight of the persons about me. My emotions were enthusiastic and sublime, and for a minute I walked round the room perfectly regardless of what was said to me. As I recovered my former state of mind I felt an inclination to communicate the discoveries I had made during the experiment. I endeavoured to recall the ideas; they were feeble and indistinct. One collection of terms, however, presented itself, and with the most

intense belief and prophetic manner I exclaimed to Dr. Kinglake, 'Nothing exists but thoughts!—the universe is composed of impressions, ideas, pleasures, and pains!'"

The impunity with which Davy had passed through these wonderful trials emboldened him to attempt the breathing of the deadly fumes from charcoal. His first attempt was made upon four quarts of carburetted hydrogen gas, of which he made three inspirations. "The first inspiration" (he tells us) "produced a sort of numbness and loss of feeling in the chest and about the pectoral muscles. After the second inspiration I lost all power of perceiving external things, and had no distinct sensation except a terrible oppression on the chest. During the third inspiration this feeling disappeared; I seemed sinking into annihilation, and had just power enough to drop the mouthpiece from my unclosed lips. A short interval must have passed during which I respired common air before the objects about me were distinguishable." On recollecting himself, he faintly articulated, "I do not think I shall die." Putting one finger on his wrist, he found his pulse threadlike, and beating with excessive quickness. Extreme giddiness, loss of memory, and numbness succeeded, with excruciating pains in the forehead and between the eyes, and transient pains in the chest and extremities.

Davy was, as far as his philosophical learning went, entirely self-instructed. He was born at Penzance, in Cornwall, on the 17th of December, 1778. Though some attempt has been made to conceal the fact, there is no doubt that his father, Robert Davy, followed the humble occupation of a wood-carver. He was known

in that town as "little Carver Davy," and his son, when young, was always spoken of there as "Carver Davy's boy." His father dying when the lad was only sixteen, his mother commenced the business of a milliner, and apprenticed her child to an apothecary at Penzance, where, for the first time, he began to show an interest in his favourite study.

"His means, of course," says his brother, Dr. Davy, "were very limited; not more extensive than those with which Priestley and Scheele began their labours in the same fruitful field. His apparatus consisted chiefly of phials, wine-glasses, teacups, tobacco-pipes, and earthen crucibles, and his materials were generally the mineral acids and the alkalies, and some other articles which are in common use in medicine." He began his experimental trials in his bedroom, in a friend's house, in which he was a favourite inmate. Here there was no fire, and when he required it he was obliged to come down to the kitchen with his crucible. His biographer, Dr. Paris, states that Davy was indebted to the accident of a wreck on the coast for a case of surgical instruments. This included a clumsy clyster apparatus, which he turned into an air-pump. The sacred vessels and professional instruments of the surgery were, without the least hesitation, put into requisition for any chemical experiments.

It can hardly be doubted that Sir Humphrey Davy's constitution, which was so vigorous in youth, withered and decayed long before he had reached old age from the effects of injuries sustained by these early experiments. He died in 1829, at Geneva, of an attack of apoplexy, but his end was singularly peaceful. When

his brother, Dr. Davy, entered the room, Sir Humphrey said, "I am dying," or words to that effect. "When it is all over, I desire that no disturbance of any kind may be made in the house. Lock the door, and let every one retire quietly to his apartment." The mortal remains of Carver Davy's son, the great philosopher and discoverer, were honoured with a public funeral, and deposited in the cemetery without the walls of Geneva.

POPULAR NOTIONS OF INVENTIONS.

When the electric telegraph wires began to be worked along our lines of railway, scientific men were amused by the absurd notions entertained of them, not only by the country people, but even by public writers. One editor inserted a leading article commenting in the following strain on the telegraph between London and Yarmouth:—

"It is a fact, which some of our readers may be ignorant of, that sparrows and other small birds which happen to perch on those mysterious lines of communication, the telegraph wires, are destined ever and anon to suffer severe shocks of electricity, the effect of which is (though we never witnessed the phenomenon) that they drop down, not dead, but half dead with amazement and terror. The shock, if severe enough, will destroy them. Electricity can be administered in doses which would kill a horse. Perhaps, by transmitting

through the telegraph wire a very powerful charge, the unhappy sparrows along the whole line, from London to Yarmouth, might be cut off. This, in case of necessity, or as a matter of cruel curiosity, might be employed as a means of getting rid of these vermin. It is not uncommon or extraordinary to see at least a hundred of these feathered depredators on one mile of wire. The length of the whole line of which we speak is 146 miles. A shock strong enough to destroy sparrow-life would, with these data, cut off from the land of the living, at one fell and fatal swoop, not less than 14,600 of these little creatures. One thousand miles of railway would in like manner, and with the same conditions, be the death of 100,000. Even supposing that death does not ensue, yet how miserable will be the state of these little animals when the whole island is covered with a veritable network of telegraphic wires! Fatal twigs these for tiny feet! The whole family of sparrows will be paralyzed. The fowls of the air will be electrified. People, as they talk with each other, and whisper to each other in unheard communion, at the distance of 1000 miles, will be causing serious inconvenience to the feathered race. We tremble to think of the consequences, and heartily recommend the case to the Society for the Prevention of Cruelty to Animals. Dog-carts sink into insignificance when compared with this wholesale palpitation—this universal twittering and consternation—among the feathered tribes. How many a sweet song will be interrupted—how many a little throat silenced—very suddenly indeed, when this mischievous machinery shall be brought into universal play!"

We need hardly inform the present generation of

readers that this amusing specimen of ignorance is founded upon an erroneous conception of the laws of electricity; and that no bird or other creature, unless its body formed part of the chain of communication, could be affected in any way by the passage of the electric fluid. Among other odd popular notions was that of the country people who thought that the humming noise made by the wind in passing through the wires was caused by the messages passing. Some believed they could tell when a train was coming by the noise. In one case, where a man's house was injured by lightning in the immediate vicinity of the line of telegraph, he conceived the calamity attributable to its influence; but, on careful investigation, in conjunction with a resident director, it satisfactorily appeared that the agency of the line was exactly opposite to that supposed by the injured party, and that, to the extent of the capacity of the wires as an electric conductor, it had alleviated and carried off the atmospheric charge from the point of its explosion in the vicinity of the injured house. It was found difficult to persuade the country folks that parcels or missing umbrellas could not be forwarded by the wires.

At Dover, an individual presented himself at the telegraph office one afternoon with a sum of money, and desired the clerk to send the money itself, in *propria forma*, up to London by telegraph, to be forwarded to a certain banker's. The money was to take up a bill due that day, and there was no time to send it by train. He seemed perfectly surprised that it could not be sent. At the terminus of the South-Eastern Railway in Tooley Street, a servant in livery came to the office, heated and out of breath, with a small parcel to be sent by telegraph

to a distant part of the country. It appears he had instructions to send it by train; but he arrived just too late for the train, and, as it was of consequence, he thought he should get out of his dilemma and expedite matters by adopting this course.

THE FIRST MARGATE STEAM-BOAT.

It is exactly fifty years since Brunel steamed down the river Thames on a voyage to Margate in a vessel propelled by a double acting marine steam-engine. Arrived at Margate, the engineer looked out for accommodation for the night. But this proved to be a difficult matter. The inhabitants were in arms against the inventor, who threatened to bring steam communication to their town, a feeling which was not confined to the persons connected with the sailing packets, but was even extended to the shopkeepers and lodging letters. So blind were they to the future advantages of that mode of conveyance, which has since given so great an impulse to sea-coast watering places, that the landlords of hotels where Brunel desired to stay for the night absolutely refused to provide him with a bed. Many years afterwards, when Brunel was in the Isle of Thanet laying out a plan for a railway to Ramsgate, he wrote from Margate to a friend:—"To-day, by mere chance, I am at the York Hotel. It was at this same hotel that, in 1814, I was refused a bed because I came

by a steamer, and every one of the comers met with a very unfriendly reception. If they knew at this moment that I came to carry off the cargoes of the steamers to Ramsgate, I might probably share the same fate." Had he lived longer Brunel might have seen the town of Margate with two lines of railway connecting it with London, and with its immediate rival Ramsgate, and assuredly no hotel-keeper in that neighbourhood would now deny that the engineer knew their interests better than they themselves. It is pleasing to think that this pioneer of steam navigation lived to see the launch of the "Great Britain" at Bristol, in 1843—a steamer of 3500 tons burden—in which the screw-propeller, which he had himself suggested in early life, was for the first time applied to a vessel of large burden.

WATT'S EARLY STRUGGLES.

Watt's first experiments in steam were undertaken when he was about twenty years of age, and while he was living in a little room within the precincts of the college at Glasgow, where he earned a bare subsistence by obtaining odd jobs as a mathematical instrument maker. Driven out of the city by the severe restrictions of the Trade corporation, against workmen who had not served an apprenticeship to their craft, some friends in the university had given him a refuge where he could be allowed the poor privilege of earning bread by the labour of his hands. A few apothecaries' phials,

and the instrument known as a Papin's digester, were at first his only tools. Next he obtained from the college to repair a model of one of Newcomen's engines, which he eagerly studied; but this was so clumsy a contrivance that the instrument maker regarded it merely as "a fine plaything;" and indeed this crude machine had hitherto been applied to no purpose, as a mechanical power, except that of pumping water from a few mines. Watt, in his own account of his experiments at this time, said:—"One Sunday afternoon I had gone to take a walk in the Green of Glasgow, and when about half way between the Herd's House and Arn's Well, my thoughts having been naturally turned to the experiments I had been engaged in for saving heat in the cylinder, *at that part of the road* the idea occurred to me, that, as steam was an elastic vapour, it would expand, and rush into a previously exhausted space; and that, if I were to produce a vacuum in a separate vessel, and open a communication between the steam in the cylinder and the exhausted vessel, such would be the consequence."

By much patience and industry Watt improved the boiler of this engine; but his ignorance of the principle of latent heat, and want of experience in the practice of mechanics, clogged his progress. No mechanics could then be found in Glasgow capable of making his large models; ignorant blacksmiths and tinmen being the only hands available. Poor as he was, Watt contrived to hire a small workshop in a back street of the city, where he himself erected a working model with the aid of his assistant John Gardiner. But while he was busied with his task his best mechanic died, and Watt,

who said at this time that he was "quite barren" of every other subject, his whole thoughts being bent on this machine, wrote to a friend, "My old white-iron man is dead—an almost irreparable loss." It was on the 5th of January, 1769—the same year in which Arkwright obtained the patent for his spinning machine, that Watt took out his patent for his steam, or as he called it, fire-engine; but his models were ill made; his resources were small; his health and spirits continually breaking down under the cares and anxieties of his life. He was often near abandoning altogether his ingenious schemes. In 1769, his spirit being embittered by hearing of an attempt to appropriate his inventions, he wrote to a friend:—"I have resolved, unless these things that I have now brought to some perfection reward me for the time and money I have lost on them, if I can resist it, to invent no more. Indeed, I am not near so capable as I once was; I find that I am not the same person that I was four years ago, when I invented the fire-engine, and foresaw, even before I made a model, almost every circumstance that has since occurred. I was at that time spurred on by the alluring hope of placing myself above want, without being obliged to have much dealing with mankind, to whom I have always been a dupe. The necessary experience was wanting; in acquiring which I have met with many disappointments. I must have sunk under the burthen of them if I had not been supported by the friendship of Dr. Roebuck. I have now brought the engine near a conclusion, yet I am not in idea nearer that rest I wish for than I was four years ago. However, I am resolved to do all I can to carry on this business, and if it does not thrive with me I

will lay aside the burthen I cannot carry. *Of all things in life there is nothing more foolish than inventing.*" And on the 31st of January, 1770, he said:—"To-day, I enter into the thirty-fifth year of my life, and I think I have hardly done thirty-five pence worth of good in the world; but I cannot help it." Such was the desponding view taken by this great benefactor of mankind of those labours by which his name has since been rendered so famous. His subsequent removal to Birmingham, and his partnership with Mr. Boulton, opened a new and happier era for the dreaming maker of instruments, who now became a practical maker of engines on a large scale. The Soho works speedily became famous all over England. Yet, in 1780, Watt and Boulton were still out of pocket by his inventions, and as late as 1783, when the former was forty-seven years old, they had reaped no profit. But for an act passed in 1775 to continue the rights of the patentees to the year 1800, in consideration of the great utility of the invention, the inventor must have been entirely deprived of the reward of his labour.

MR. BOULTON, OF BIRMINGHAM.

Mr. Boulton, the practical business-like partner of James Watt, though entitled himself to high rank as an inventor, never forgot to acknowledge the transcendent merits of his partner. The steam-engine was in his

mind the pride of the establishment over which he ruled. With a curious forgetfulness of his illustrious partner's origin, Boulton once said to Sir Walter Scott, in reply to some remark, "That is like the old saying—in every corner of the world you will find a Scot, a rat, and a Newcastle grindstone." "You ought," retorted Sir Walter, whose national feeling could not tolerate even a joke at the expense of his country, "to have added —and a *Brummagem button*." "Ah," replied Boulton, roused in his turn to a spirit of pride in his birth-place, "we make something better than buttons in Birmingham, Sir Walter;" and then added in a tone of dignity, "We make steam-engines." Boswell, the biographer of Dr. Johnson, has left us an interesting anecdote of Boulton. Boswell, who despised trade, and who regarded the writing of a preface to a commercial dictionary as a degradation of the talents of his master, nevertheless condescended to visit the Soho works in 1776, there to inspect the new machines of his fellow-countryman which had then just been completed. "I shall never forget," he says, "Mr. Boulton's expression to me when surveying the works: 'I sell here, sir, what all the world desires to have—POWER.' He had," adds Boswell, "about 700 people at work. I contemplated him as an iron chieftain, and he seemed to be a father of his tribe." Another interesting anecdote is told by Boswell in connection with this visit, interesting as illustrating the character of Boulton. "One of the men," Boswell tells us, "came to Boulton, complaining grievously of his landlord for having distrained his goods. 'Your landlord is in the right, Smith,' said Boulton; 'but I'll tell you what—find you a friend

who will lay down one-half of your rent, and I'll lay down the other, and you shall have your goods again.'"

Boulton devised some remarkable improvements in the machinery for coining, and attained to such rapidity and perfection of execution that he was employed by the Government to re-coin the whole copper money of the kingdom. Under his superintendence several foreign governments established his system. It is said that Boulton's senses were so acute that, while sitting in his office at Soho, he could detect, by a change in the sound of the motion, the least derangement in the machinery of his vast establishment.

IMPRACTICABLE INVENTORS.

Brunel, was continually tormented with impracticable and ignorant inventors, who solicited his attention for projects frequently of the most absurd kind. An Irish gentleman once submitted to him a design for a kind of hood for a carriage, the merit of which was that in fine weather it was to hang under the vehicle ready for use. "Impossible," exclaimed Brunel, after a moment's examination; "such a mass could never be stowed away in so small a space." "Do you think so?" said the Irish gentleman, not at all taken aback. "Ah! then we will soon get over that. The thing must be left at home in fine weather. Shan't want it then, you know."

On another occasion his benevolent feeling was appealed to, to give attention to a new means of sweep-

ing chimneys, intended to obviate the necessity of the climbing boys, who were at that time used for this cruel employment. The plan was extremely simple: a broom was to be worked from above, as well as from below and thus every nook, whichever way it turned, was to be easily swept out.

"Excellent," said the great engineer; "but you have not told me how the rope is to be got to the top."

"Nothing more simple," replied the sanguine inventor. "Of course, a boy will go up with it first."

Sometimes he was annoyed at finding that a kindly word, or a mere formal expression of politeness which he had used towards some of these tormentors, was construed into an approval of their schemes, which were forthwith announced as sanctioned by Brunel's approbation. This occurred in the case of a new machine a "criopyrite" or fire-ram, invented by a Mr. Collier. This gentleman not only put forth his invention as sanctioned by Brunel, but referred inquirers to the agent of the latter, to certify to the soundness of his principle. Brunel was naturally indignant at this, and he replied, "Nothing is more preposterous than the account which has been published respecting this engine, which, it is added, consumes no more than one twentieth part of the fuel required for a steam engine of the like power. . . . Having been called on to witness its action and to give my aid in directing its power, I am enabled to state that the new engine supposed to possess a power equal to twenty horses, has not yet to my knowledge moved without the external aid of two or three men."*

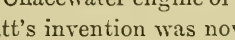
* Beamish's Memoir of Sir M. I. Brunel, 1862.

THE CORNISH MINERS AND THE ENGINE.

The first practical trial of Watt's engine took place in Cornwall. The sea had broken into some valuable copper mines in that county, the news of which reached his partner, who at once determined to put the invention to the test, and wrote to the miners informing them of its success, and of the means it afforded them of retrieving their disaster. The offer was sufficiently feasible to induce the Cornish miners to undertake a journey to Birmingham, on purpose to inspect the new engine. Its power to extricate them from the position of "drowned out," so terrible to the poor miners in that part of England, was probable, but it was costly—apparently an insuperable difficulty. Boulton, with the shrewd sense of a business man, then proposed to the miners to supply the capital himself, on an arrangement to be allowed a royalty of one-third of the value of the proved saving of coal (which is dear in Cornwall), as compared with the best of Newcomen's engines. The offer was accepted, and Watt himself being the only man capable of checking the operations of the machine of which he was the inventor, repaired to Cornwall to superintend the work. The superstitious Cornish people looked with a sort of vague terror upon this monster workman, who toiled night and day to deliver them from the terrible inundation. The noise had a sort of fascination for them, and, as Watt humorously said in a letter to his partner, "the people seemed to be no more taken with modest merit in an engine than in a man." Whether believers or not, the

velocity, violence, magnitude, and horrible noise, as Watt said of the engine, long continued to give unusual satisfaction. Having on one or two occasions trimmed the engine to end its strokes gently and make less noise, he found that the chief of the miners could not rest unless the machine worked more furiously, and the inventor was at length content to leave the matter to the engine-man. Even here, Watt's inventive faculties did not sleep. He devised a sort of meter to ascertain the saving effected, which marked the number of strokes, and being enclosed in a box could not be tampered with. The saving of coal was soon found to be nearly three-fourths of the quantity used with Newcomen's engine, or equal to a saving on the Chacewater engine of £7,200 a year. The success of Watt's invention was now proved, and orders for the new "fire engine" soon reached Soho.

THE DUKE AND THE INVENTOR.



The propensity of military men, even of the highest genius, to cling to the ideas and fashions in which they have been educated, was never better exemplified than by a correspondence which took place some years since between the late Duke of Wellington and Mr. Wright, the inventor of certain improvements in percussion caps. In 1820, percussion fire-arms had already almost superseded the old flint lock; but there were still some practical objections to the innovation which were readily taken advantage of by the old-fashioned shots of that

day. The disadvantage of the detonating powder then in use was that it quickly rusted the lock of the barrel, that it was affected by damp, and that the charcoal in the gunpowder occasioned the accumulation of dirt. In that year Mr. Wright, who was an ardent sportsman as well as an excellent chemist, was led to turn to practical account some experiments he had made with fulminating mercury as far back as the year 1805, soon after its discovery. He primed some caps with a preparation of this powerful detonator mixed with a solution of benzoni, as a protection against damp, and quickly found by experiment that the idea was valuable. After many trials he wrote to the Duke of Wellington pointing out the advantages of the new substance, as being free from damp, producing no rust, and being safer than the old preparation. In the same letter Mr. Wright suggested the application of the principle of percussion to ships' guns. The duke's reply was as follows:—"The Duke of Wellington presents his compliments to Mr. Wright, and has the honour to inform him, that the application of fire by percussion to naval ordnance has been considered by various committees of officers of the Navy, and of the Artillery, each of which has decided against it in every form. There are strong objections to the use of the copper cap, mentioned by Mr. Wright, which Mr. Wright has not taken into consideration."

The value of Mr. Wright's invention is now placed beyond doubt. In 1823, he published a full account of its process, and its superiority was soon afterwards generally admitted; but although subsequently adopted by Government it never received any other official recognition than is contained in the above letter. "I

believe," says Dr. Wright, the son of the inventor, "that the only business transaction which ever arose out of the invention was an expenditure of money in stopping some attempts to pirate and patent the discovery." The late Lord Dundonald, better known by the name of Cochrane, under which he gained his dashing naval victories, wrote, after reading the correspondence above alluded to:—

"SIR, — I thank you for your very interesting note, showing how the greatest characters may be led to acquiesce in wrong conclusions (from mental indolence) by trusting to ignorant, jealous, or interested officials. I shall preserve your valued communication as a testimonial to the fact, how difficult it is for merit to obtain a fair hearing.—I am, Sir, your obedient servant,

"DUNDONALD."

Dr. Wright remarks that there is a great difference between the style of these letters; but it must not be forgotten that the latter was written after the superiority of the percussion principle had been fully demonstrated.

THE EAR TRUMPET.

THE best kind of ear-trumpet, that useful invention to which the deaf owe so much, was devised by Dr. Arnott, the well-known scientific writer. Dr. Arnott was travelling by railway at night, when a window of the carriage being accidentally left open, caused him an inflammation of the throat, which, spreading upwards,

resulted in permanently dulling the sense of hearing. Meditating upon a means of relieving himself in some measure from this troublesome affliction, he observed that persons whose hearing is good, will involuntarily hold the concave hand to the ear when straining to catch a distant sound. Finding how useful this assistance was, and reflecting that many animals are endowed by nature with the power of turning the ears in the direction of any sound, he procured two small wooden cups, and joining them by a piece of wire, made an apparatus which could be adjusted to the ears pretty nearly as a pair of spectacles are fitted to the eyes. The result was satisfactory, and he discovered further that, when pressing these cups forward by the hands against the backs of the ears, or keeping them so forward by a band crossing in front, the useful effect was increased. The well-known form of ear-trumpet, consisting of a long, flexible tube, with a small trumpet opening, which the afflicted person holds near the mouth of the speaker, is a more powerful conductor of sound; but all these contrivances are so inconvenient as to be frequently rejected. It is to Dr. Arnott's happy observation of the habits of men and animals that the deaf are indebted for an instrument which can be worn at all times without any more trouble or annoyance than is given by a pair of spectacles.



THE ORIGIN OF OUR CAST IRON

THE ORIGIN OF OUR CAST-IRON.

ABRAHAM DARBY AND THE SHEPHERD-BOY SECRETLY CASTING THE IRON POT.

The cast-iron which comes from the blast-furnace may, from its useful quality of fusibility, be immediately used, as every one knows, for manufacturing purposes by re-melting it and pouring it into moulds of any required shape, this being the business of the ironfounder. Simple as this appears, the use of cast-iron is only of modern date compared with that of its purer rival. It may be obscurely traced to the fifteenth century, if not earlier, but the process of casting was beset with many mechanical difficulties, which were not thoroughly vanquished till about 1700, when Abraham Darby, an intelligent mechanic, who had brought some Dutch workmen to establish a brass-foundry at Bristol, conceived that cast-iron might be substituted for brass, and prevailed upon his workmen to make the experiment, but without success, until a happy incident occurred in connection with which Dr. Percy, in his great work on "Metallurgy," relates an interesting anecdote. About this period, a Welsh shepherd-boy, named John Thomas, succeeded in rescuing a flock of his master's sheep from a snow-drift, and later in the spring of the same year, during heavy rain and the melting of the snow, he swam a river to fetch home a herd of mountain cattle. These he collected and drove to the river; but the ford had now become a boiling torrent. He nevertheless crossed it on the back of an ox, and brought home the whole herd in safety. As a reward for his courage, his

master presented him with four of the sheep which he had saved. He sold their wool in order to buy better clothing for himself, and afterwards disposed of the sheep, so that he might obtain money to travel to Bristol and seek his fortune. Afraid of being pressed for a soldier if found in Bristol out of place, as it was then the time of the Duke of Marlborough's wars, he requested his master to recommend him as an apprentice to a relative, who was one of the partners of the celebrated Abraham Darby of the Baptist Mills. The boy was accordingly sent into the brass-works until he should procure employment. As he was looking on during the trials of the Dutch workmen to cast iron, he said to Abraham Darby that he thought he saw how they had missed it. He begged to be allowed to try, and he and Abraham Darby remained alone in the workshop the same night for the purpose. Before morning they had cast an iron pot. The boy Thomas entered into an agreement to serve Abraham Darby and keep the secret. He was enticed by the offer of double wages to leave his master, but he continued nobly faithful, and afterwards showed his fidelity to his master's widow and children in their evil days. From 1709 to 1828 the family of Thomas were confidential and much-valued agents to the descendants of Abraham Darby. For more than one hundred years after the night in which Thomas and his master made their successful experiment of producing an iron casting in a mould of fine sand, with its two wooden frames and its air-holes, the same process was practised and kept secret at Coalbrookdale with plugged keyholes and barred doors.

ARNOLD THE WATCHMAKER, AND HIS FRIEND BRÉGUET.

The notion that rivals in art are necessarily antagonistic in feeling, was never more completely falsified than in the case of the celebrated English watchmaker Arnold, and his friend M. Bréguet—both famous in the annals of horology for their useful inventions. A watch made by Bréguet fell into the hands of Arnold, who examined it with delight and astonishment. The perfection of the work, and the simplicity of the mechanism filled him with admiration; for as yet English watchmakers had not been accustomed to esteem the labours of their foreign brethren. Arnold knew nothing of the maker but the name on the watch, and where he also read the word "Paris;" but with an enthusiasm for his art he determined to set out for France immediately to make Bréguet's acquaintance. Arrived in Paris, he obtained an interview, and a strong friendship immediately arose between the two watchmakers. As a proof of his love and esteem for Arnold, Bréguet desired him to take his son to England, and instruct him in their art. Arnold was the inventor of those improvements known as the compensation pendulum, the compensation escapement and balance, and many other improvements in watches and other timekeepers, especially chronometers, for which he received several premiums from the Board of Longitude. He was also the author of several tracts, illustrative of the principles of his art. His wife was a remarkable person, and is said to have rendered great

assistance to her husband in his calculations. Their son, John Roger Arnold, was also a man of considerable ingenuity, and was the inventor, among other things, of an expansion balance for chronometers. In the Patent Museum, at South Kensington, is an interesting painting in oil, of a family group, representing Mr. Arnold and his wife seated, with their son standing between them, and listening to his father who is explaining the construction of a chronometer which he holds in his hand.

Bréguet was perhaps even more eminent as an inventor and practical watchmaker. Though not a Frenchman by birth, Bréguet had descended from one of the numerous French Protestant families who were compelled to fly from France, by the Edict of Nantes. He was born at Neufchatel, in Switzerland, and began life as a simple workman: a fact which he never forgot; for it is said that when he became eminent, he was always a firm friend to young men of his own trade, and was enabled to assist many of them, from the warm interest which he took in their welfare. At school, Bréguet had appeared remarkable only for dulness; and there seems no doubt that he gave to his masters the impression that he was deficient in intellect. His father-in-law, who was a watchmaker, undertook to teach him that art, but Bréguet showed at first no interest in it. It was not until the father-in-law, in despair, had sent him to a watchmaker at Versailles, that he began to apply himself seriously to the study of the mechanism of watches. His apprenticeship ended, the master expressed himself well satisfied with the industry and perseverance of the young Swiss work-

man; but Bréguet only replied, "Master, I have a favour to beg of you. You have praised my industry, but I know that, at least in the early part of my career here, I did not employ my time to the best of my ability. It will be a satisfaction to me to be allowed to work three months more under you, without wages." This request established a warm friendship between the master and the apprentice. The death of his father and mother about this time compelled Bréguet to labour for the support of his sister; but he nevertheless found time to attend the course of lectures on mathematics, delivered by the Abbé Marie, at the Collége de Mazarin, and to obtain a knowledge which he considered indispensable to the perfection of his art. When the French Revolution began, Bréguet had already founded the manufactory which afterwards produced so many admirable specimens of watchmaking. It is a melancholy fact that this first establishment was destroyed by the revolutionary mob, while Bréguet himself was compelled to fly from the country with his son, and to remain abroad two years, during which time he was indebted to the assistance of friends for the means of continuing the exercise of his profession. Happily, better days arrived; the revolution at an end, Bréguet returned to his adopted country, and opened a new manufactory, where he grew in reputation, and became more and more prosperous, until his death in 1823. An eloquent French writer, in commenting on Bréguet's labours, observes, "Bréguet brought all parts of his art to perfection. Nothing can be more delicate, nor more ingenious, than his detached escapement. He invented also an escapement, called Natural, in which

no oil is necessary, and in the mechanism of which there is no spring. Another still better and finer invention of Bréguet is that of the duplex escapement, which also dispenses with the necessity for oil. Portable marine watches or chronometers may without injury experience any change of position, except that caused by the rolling of a vessel. Bréguet conceived the idea of enclosing the whole mechanism of the escapement and the spring in a cylinder, which performs a complete revolution every two minutes.

"Bréguet also discovered a method of preserving the regularity of his chronometers, even in case of their being struck or experiencing a fall to the ground. Such is the effect of his *parachute*. An English observer, General Brisbane, possessing one of these chronometers, subjected it to great trials by constantly wearing it on horseback; and during several long voyages, in sixteen months the greatest variation was only a second and a half, that is to say, the 57-600th part of a diurnal revolution.

"At the time when Bréguet obtained this great result, adds M. Charles Dupin, the writer referred to, the English parliament, with British generosity, had offered a reward of two hundred and fifty thousand francs to the artist who would make a chronometer for ships, the daily variation of which should not exceed two seconds. No one had gained this prize when Bréguet exceeded this limit, as above stated."

THE INVENTOR AND THE PIRATES.

The chief annoyance to which Watt was subjected after his steam-engine had begun to attract attention arose from the attempt of dishonest persons to pirate his invention, and thus to rob him of the fruit of his lifetime of toil and trouble. Watt had found that the best way of obtaining continuous motion was by the crank. "Not," Watt says, "in its simple form an original invention." And he adds modestly, "the true inventor of the crank rotative motion was the man, who unfortunately has not been deified, who first contrived the common foot lathe. The applying it to the engine was merely taking a knife to cut cheese which had been made to cut bread."

It happened that, while Watt and his partner Boulton were constructing models for their crank at Soho, a number of their workmen were one Saturday evening drinking their ale at a poor public-house called the "Waggon and Horses," in the village of Handsworth, near by. The nature of the models preparing at the works was a secret which the men were expected not to divulge; but as the drink passed round, they became talkative, and one of them named Cartwright—a man who was afterwards hanged—began to talk boastfully of his master's design; probably urged on by a stranger among the company, who, though in a workman's dress, might easily have been detected as belonging to a superior class. The man sat in a corner, and as soon as the workmen began to talk freely, became silent and atten-

tive, not only to every word of the conversation, but to a rough sketch which Watt's workman, finding a piece of chalk at hand, proceeded to make on the table. No sooner had they gone than the assumed workman started for Birmingham, and took post horses for London. A few days later, Watt's crank motion was registered in the patent office by a man named Wasborough. Watt was extremely angry at the trick which had been played him, and averred that Wasborough had stolen the invention from him by the most infamous means; but his inventive genius helped him to defeat the fraud. In a few weeks he devised his well-known "sun and planet motion." This was unfortunately not the only occasion on which the great inventor had suffered from the roguery of plagiarists. When a young man, in his little mathematical instrument shop in Glasgow, a prosperous London maker had impudently appropriated his drawing machine. Another plagiarist had coolly appropriated his micrometer. His crank had now been lost to him through the idle talking of one of his own men. His property in the condensing engine itself, which had cost him twenty years of anxiety and labour, was threatened. The Cornish miners, whose industry had been so enormously benefited by it, and of whom Watt claimed only one-third of the money that he undertook to save them, made artful excuses for evading the fulfilment of their engagement. "We have been so beset with plagiaries," he wrote to a friend, "that, if I had not a very good memory of my doing it, their impudent assertions would lead me to doubt whether I was the author of any improvement on the steam-engine, and the ill-will of those we have most essentially served,

whether such improvements have not been highly prejudicial to the commonwealth!"

Though Watt and his partner succeeded in their lawsuits, they were nearly ruined by the expense of litigation. During the last four years of their patent alone, these expenses amounted to between five and six thousand pounds. After one of these vexatious trials, "I remained," says Watt, "nearly as much depressed as if we had lost it. The stimulus to action was gone, and but for the attentions of my friends I ran some risk of falling into stupidity." Even after he had retired with a very moderate fortune, that he might enjoy the quiet for which alone he was fitted, he spoke of himself as incapable of any further efforts, ascribing his prostration to the vexation he had endured for many years from this harassing lawsuit.

A QUICK DECISION.

The elder Brunel was habitually absent in society; but no man was more remarkable for presence of mind in an emergency. Numerous instances are recorded of this latter quality, but none more striking than that of his adventure while in the act of inspecting the Birmingham Railway. Suddenly in a confined part of the road a train was seen approaching from either end of the line, and at a speed which it was difficult to calculate. The spectators were horrified; there was not an instant to be lost; but an instant sufficed to the expe-

rienced engineer to determine the safest course under the circumstances. Without attempting to cross the road, which would have been almost certain destruction, he at once took his position exactly midway between the up and down lines, and drawing the skirts of his coat close around him, allowed the two trains to sweep past him; when, to the great relief of those who witnessed the exciting scene, he was found standing untouched upon the road. Without the engineer's experience which enabled him to form so rapid a decision, there can be no doubt that he must have perished.

BLUNDERS OF THE TELEGRAPHERS.

Before the telegraph operators became so expert as at present, ludicrous blunders were of frequent occurrence from the necessary ambiguity in transmitting one letter at a time. An American manager of a telegraph company gives an instance as of recent occurrence upon the line between Boston and New York. A gentleman sent a despatch requesting parties in New York to forward sample forks by express. When the message was delivered it read thus, Forward sample for K. S.

The parties who received it replied by asking what samples K. S. wanted?

Of course the gentleman came to the office and complained that the despatch had been transmitted incorrectly, and the operator promised to repeat it. Accord-

ingly he telegraphed the New York operator that the despatch should have read, Forward sample forks. The New York operator, having read it wrong in the first instance, could not decipher it differently now. He replied that he did read it, Sample for K. S., and so delivered it.

"But," returned the Boston operator, "I did not say for K. S. but f-o-r-k-s!"

"What a stupid that fellow is in Boston!" exclaimed the New York operator. "He says he didn't say for K. S., but for K. S."

The Boston operator tried for an hour to make the New York operator read it forks, but not succeeding, he wrote the despatch upon a slip of paper, and forwarded it by mail; and it remained a standing joke upon the line for many months afterwards.

THE LAST DAYS OF JAMES WATT.

When Watt was in his seventy-fifth year, and long after he had retired from business, he was consulted as to a means of conveying water from a peninsula across the river Clyde to engines at Dalmarnock, a problem of great difficulty, and which baffled the scientific skill of any other engineers that the Water Company had been able to discover. Watt, who was above all things distressed by the fear of his mental faculties deserting him in old age, and who had mastered the German language, when an old man to test his memory, was not sorry for

an opportunity of once more taxing his inventive faculties. The plan which he suggested was extremely ingenious and altogether novel. The chief difficulty was to adapt the pipes to the irregular bed of the river. The peculiar formation of the tail of a lobster at once suggested to the wonderful old man the solution of the problem. Taking this for his model, he forwarded a plan of a tube articulated in this peculiar manner; a sketch was executed, the pipes laid down, and the great inventor had the satisfaction of hearing that his idea had proved perfectly successful. Among other things devised by Watt in the leisure moments of his grander schemes were an arithmetical machine, a spiral oar for the propulsion of ships, a steam carriage for use on common roads, a machine for copying letters, an instrument for measuring the specific gravity of fluids, a regulator lamp, a plan for warming buildings by steam, and a machine for drying linen. To economize labour, or save annoyance to the book-keeper in his country house, the sailor in his ship, the traveller on the highway, the clerk at his desk, the chemist in his laboratory, the student by his lamp, or even the poor laundress in her daily work were equally the objects of his busy mind.

"I remember," says a lady who knew him well, "a celebrated Swedish artist having been instructed by him that rats' whiskers make the most pliant painting-brushes; ladies would appeal to him on the best means of devising grates, curing smoking chimneys, warming their houses, and obtaining fast colours. I can speak from experience of his teaching me how to make a dulcimer and improve a Jew's-harp." The same lady has given us an interesting sketch of Watt's personal

appearance. "He was," she says, "one of the most complete specimens of the melancholic temperament. His head was generally bent forward, or leaning on his hand in meditation, his shoulders stooping and his chest falling in, his limbs lank and unmuscular, and his complexion sallow. His utterance was slow and unimpassioned, deep and low in tone, with a broad Scottish accent; his manners gentle, modest, and unassuming. In a company where he was not known, unless spoken to, he might have tranquilly passed the whole time in pursuing his own meditations. When he entered a room, men of letters, men of science, nay, military men, artists, ladies, even little children thronged around him.*

The last of all his inventions was his machine for taking reduced copies of busts and statues. At Steathfield, in Staffordshire, whither he had retired, he had a small workshop adjoining his bedroom. Here he spent usually the greater part of the day, attired in a woollen suit, a leathern apron, and a rustic hat—the same which he had worn when a humble workman forty years before. He succeeded so well with his machines as to produce specimens of his sculpture chiefly in the shape of busts, which he distributed among his friends, describing them as "the productions of a young artist just entering his eighty-third year." It was upon this machine that Watt was engaged, working contentedly at his "likeness lathe," as he termed it, when death put an end to his busy career, and the unfinished machine was left, standing a touching memorial of his departure.

* Autobiography of Mrs. Schimmelpenninck.

THE SECRET OF MAKING DOLLS' EYES.

How a Birmingham manufacturer learnt the secret of making dolls' eyes, and how Birmingham came to be extensively engaged in making these apparently trifling but really important little articles was amusingly explained by Mr. Ostler, of that city, some years ago before a committee of the House of Commons :—"A respectable looking man in the city," says Mr. Ostler, "asked me if I could supply him with dolls' eyes, and I was foolish enough to feel half offended ; I thought it derogatory to my dignity, as a manufacturer, to make dolls' eyes. He took me into a room quite as wide, and, perhaps, twice the length of this committee room, and we had just room to walk between stacks, from the floor to the ceiling, of parts of dolls. He said, 'These are only the legs and arms; the trunks are below.' But I saw enough to convince me that he wanted me to make a great many eyes, and as the article appeared quite in my own line of business, I said I would take an order by way of experiment; and he showed me several specimens. I copied the order. He ordered various quantities, and of various sizes and qualities. On returning to my hotel, I found that the order amounted to upwards of £500. I went into the country and endeavoured to make them ; I had some of the most ingenious glass-toy makers in the kingdom in my service ; but when I showed it to them, they shook their heads, and said they had often seen the article before, but could not make it. I engaged them by

presents to use their best exertions; but after trying and wasting a great deal of time for three or four weeks, I was obliged to relinquish the attempt. Soon afterwards I engaged in another branch of business (chandelier furniture), and took no more notice of it. About eighteen months ago I resumed the trinket trade, and then determined to think of the dolls' eyes; and about eight months since I accidentally met with a poor fellow who had impoverished himself by drinking, and who was dying in a consumption, in a state of great want. I showed him ten sovereigns, and he said he would instruct me in the process. He was in such a state that he could not bear the effluvia of his own lamp; but though I was conversant with the manual part of the business, and it related to things I was daily in the habit of seeing, I felt I could do nothing from his description (I mention this to show how difficult it is to convey, by description, the mode of working). He took me into his garret, where the poor fellow had economized to such a degree, that he actually used the entrails and fat of poultry from Leadenhall market to save oil (the price of the article having been lately so much reduced by competition at home). In an instant, before I had seen him make three, I felt competent to make a gross."

Mr. Ostler afterwards became a large manufacturer of these articles.

THE "SPINNING JENNY" AND THE "MULE."

JAMES HARGREAVES, who has been called "one of the martyrs of scientific industry," invented the spinning jenny in 1767, a most original device, differing widely from the water frame of Arkwright. It was while working as a poor weaver in a factory near Blackburn, that he first conceived his idea of making a machine which would spin more threads than one at a time. But no sooner had he completed it than the persecution of his fellow-workmen compelled him to leave his native place. Fortunately, some of his jennies, which he had sold, escaped the fury of the mob; the importance of the invention was demonstrated, and its use rapidly extended. It was on one of these machines, only two years after their invention, that Samuel Crompton, then a youth of sixteen, spun with eight spindles the yarn which he afterwards wove into quilting. The history of Crompton's invention is still more romantic. Strongly interested in the beautiful devices for saving labour, which he had daily under his eye, the young man's mind turned constantly to the idea of still further improvements; and it was in 1774, when twenty-one years of age, that he made the first step towards putting these notions in practice by constructing a new spinning machine, which was finally known as the "mule," it being a kind of cross between Arkwright's machine and Hargreaves jenny. It was at first called the "muslin wheel," and the "Hall i' th' Wood wheel," from the house in which Crompton lived, and in which he in-

vented it. Never did a poor cotton-spinner inhabit a more romantic dwelling. It was a noble old mansion, with many gables and twisted chimneys, and ornamental woodwork let into the external plaster. This rather dilapidated house had been the residence of an old wealthy Lancashire family, and when Crompton lived there in his childhood, was surrounded by ancient oaks standing in a beautiful landscape. In a corner of this poetical home Crompton lived. It cost him five years to perfect his idea of the mule, working in secret, and without sympathy or aid, and generally in the night time when his day's labour at weaving was done. This midnight work, the strange sounds occasionally heard in the large upper room of the house, and the lights seen glimmering through the old lattice-framed casements, far into the night, spread the rumour that the old mansion was haunted; but when it became known that the cause of all this was the young weaver who was working with bits of wood and iron, they pointed at Crompton as he went along as the "conjuror." His machine exhausted every penny he could spare from his scanty earnings; and to help him in getting tools he had to hire himself with a violin, on which he taught himself to play tolerably well, to perform in the orchestra at the Bolton theatre, where he received eighteen pence a night.

The old trouble of inventors—machinery riots—soon came to teach him the danger of attempting to benefit his fellows by ingenious devices for shortening labour. The cry everywhere was "Men, not machines!" and the terror of this movement reached the poor weaver in his lonely dwelling. He was compelled to take his

machine to pieces and hide it in a garret near the old hall. It was not until some time after this storm had blown over that he ventured to bring out the pieces, and fit them together again; but from that time its success was established, and he began to reap the profits of his ingenuity. Misfortune, however, in some shape, always pursued him. Every one succeeded better with Crompton's mule than Crompton himself. Robert Peel made mules in his own factory, and entered into competition with the inventor; but it is stated he offered Crompton a place of trust in his establishment, and even a partnership, which the pride and independence of the latter led him to refuse. Mr. Dale, of Lanark, turned the mules with water, and increased their power greatly. Arkwright used them in his manufactories, and doubled his wealth, leaving a colossal fortune to his children. But Crompton lived at Oldham in comparative poverty; yet the country owed him much.

In 1812, when Government assigned him five thousand pounds, as a national reward, the duty paid by cotton, imported to be spun on his machines, came to more than one thousand pounds a working day.

THE ORIGINAL SEWING MACHINE.

In the year 1841, Elias Howe, a native of Cambridge Port, Massachusetts, first conceived the idea of constructing a really practical sewing machine. I know

of no higher example of patient industry and perseverance, indeed, I may say, of devotedness to science (says Mr. Alexander, to whose interesting paper recently read before the Society of Arts we are indebted for these particulars), than that displayed by Howe in his early career. A young mechanic, only twenty-two years of age, hardly capable of supporting himself and those most dear to him on his scant earnings, he laboured manfully in a little garret in his native town at his self-imposed task during the few hours that were spared to him after the ordinary labours of the day were ended. He became enthusiastic, and although, as he says, he could not devote his attention to the subject during his working hours, he thought upon it when he could, both day and night. It grew upon him till he felt impelled to yield his whole time to it, and being promised assistance by a friend, he devoted himself exclusively to the construction and practical completion of his machine. The result was that in 1845 he perfected his first sewing machine, and in order to test its practical success, he sewed with it all the principal seams in two suits of clothes. On the 10th of September, 1846, he obtained his patent.

In Howe's original machine, a curved needle attached to the end of a vibrating lever was combined with a reciprocating shuttle for producing the lock-stitch. The needle had an eye near its point, and a groove formed along the upper and under sides, to allow of the thread lying therein, and so passing more easily through the cloth. The cloth was attached to pins on the edge of a thin steel rib called a "baster plate," probably from the fact of its serving the purpose

of a basting thread in holding the two thicknesses of material together whilst being stitched. This plate formed a portion of the feed mechanism for propelling the cloth; it was carried along step by step by the teeth of a small pinion which geared into holes made in the baster plate, an intermittent rotatory motion being imparted to the pinion by self-acting mechanism working in concert with the needle and shuttle. This feed motion was found to be defective in many respects, and has since been entirely abolished in all sewing machines. The cloth was held in a vertical position against the side of the shuttle race, by a spring presser-plate, at the part where the needle entered. The shuttle was driven to and fro in its race or groove by two strikers, carried on the ends of vibrating arms worked alternately by "cams." The most important features embodied in this machine were the adaptation of contrivances for giving the requisite tension to the needle and shuttle-threads, for taking up the slack formed on the needle thread when the needle enters the cloth, for tightening and drawing up the stitch, and for supporting the cloth against the thrust and withdrawal of the needle. Shortly after obtaining his patent in America, Howe sent over a machine to this country, and disposed of his invention to Mr. William Thomas for a trifling amount.

Shortly afterwards, Mr. Thomas obtained a patent for the machine in England, soon after which Howe himself arrived here to assist him in adapting the machine to the peculiar kind of work required, namely, stay-making. Howe does not appear to have prospered here, for in the spring of 1849, indebted to a friend for

a steerage passage home, he returned to America, poorer if possible than when he left. He found his wife on a bed of sickness and in a state of utter destitution. Ten days after his arrival she died. During his absence in England his patent had been extensively infringed, but in 1850 he commenced legal proceedings, and succeeded in every case in establishing the validity of his patent.

In the course of these proceedings a prior claim to the invention of the sewing machine was set up by Walter Hunt, who was said to have constructed, exhibited, and sold, in 1834 and 1835, shuttle or lock-stitch sewing machines, similar in all essential particulars to Howe's. There is no doubt that Hunt had tried his hand at a lock-stitch sewing machine, and was the inventor of the shuttle or lock-stitch, but it was never satisfactorily proved that such machines were so far perfected as to render them more than abortive experiments. The turning point in Howe's career had now arrived, and fortune soon began to smile upon him. In 1853 he granted his first licence, and in 1855 was enabled to regain possession of the whole of his patent, which at one period he had entirely disposed of, in order to meet the pressing demands that were made upon him. His patent rights are now finally acknowledged, and his patent being prolonged for a term of seven years, he receives a royalty from every sewing machine established in America, from which he is said to derive an income of upwards of fifty thousand pounds per annum.

THE SAFETY LAMP AND ITS INVENTOR.

The year 1815 was rendered memorable by the invention of the safety lamp. The process by which its inventor advanced to the discovery is curious and instructive. First, he ascertained, by full and exact inquiries, all the facts of the case as known to the miners. Secondly, he proceeded to learn more fully the properties of the agent which he was to attempt to control. What is this fire-damp? He analyzed it and found it to be, as other chemists had said, a variety of carburetted hydrogen gas. The next question was; what will kindle it? A red-hot iron will not; a burning coal will not. It therefore requires a higher degree of heat to inflame it than most other explosive gaseous mixtures. And here an important inference met him—that if the gas, when on fire, were cooled, it would be extinguished. Again, carburetted hydrogen, by burning, produces carbonic acid, and the atmospheric air with which it is mixed in the explosive compound produces nitrogen; and each of these products, added to the explosive mixture, impairs, or even destroys its power of exploding; and, therefore, since these rise from a burning lamp, they would of themselves prevent the communication of the flame through the open chimney of the lamp. His next inquiry was—Under what circumstances does the fire-damp burn with explosion? The general reply is, when mixed with air; but experiments were instituted to ascertain the effect of different proportions of air. One part of fire-damp,

and any portion of air less than four parts, burnt without explosion; seven or eight of air to one of the other, constituted the most highly explosive mixture. In fifteen of air to one of fire-damp a lamp burnt without explosion, and with the flame greatly enlarged. Davy now came to the question, Through what channels (if there be any) between two separate portions of these explosive mixtures will the flame, when applied to one of them, refuse to pass the other? Will it pass through a tube? This brought him to the grand discovery; for it appeared, that the flame of the most explosive mixture would not pass through a small tube; that the communication was more easily prevented, in proportion as the tube was of a better conducting substance, and, therefore, operated by cooling the flame below the point of kindling. The problem, therefore, was only how to surround a lamp with a transparent envelope, communicating with the surrounding air by metallic tubes, in order that the air might enter freely to feed the lamp, while the flame would not be communicated to the surrounding atmosphere, in the most explosive state in which it ever could exist in a coal mine. Subsequent experiments proved, that in case the diameters of the tubes were very small, their lengths might be diminished to mere apertures; and hence it was only necessary to surround the lamp with wire gauze, and the air would enter freely to supply the lamp, while the flame could not pass through the apertures of the gauze.

Some friends having spoken of Davy in the highest terms to Count Rumford, the latter was induced to enter into a negotiation, for the purpose of engaging the young chemist as a lecturer at the Royal Institution.

This occurred in 1801, and in February, as appears by the following extract from the minute-book, he was engaged:—"Monday, Feb. 16, 1801. Resolved, that Mr. Humphry Davy be engaged in the service of the Royal Institution, in the capacities of assistant lecturer in chemistry, director of the laboratory, and assistant editor of the journals of the institution; and that he be allowed to occupy a room in the house, and be furnished with coals and candles, and that he be paid a salary of one hundred guineas per annum."

From that period, his fame and popularity constantly increased. His brother tells us, that he was in the habit of receiving letters of the most laudatory nature, many written by females, who regarded him with great admiration. There is an entertaining anecdote illustrative of his popularity, even among the more humble classes. He was passing through the streets one fine night, when he observed a man showing the moon through a telescope. He stopped to look at the earth's satellite, and tendered a penny to the exhibitor. But the latter, on learning that his customer was no less a person than the great Davy, exclaimed with an important air, that "he could not think of taking money from a brother philosopher." Correspondents addressed him from all parts. A letter sent to him from Italy reached him safely, though it only bore the mysterious superscription:—

SIROMFREDEVI,
LONDRA.

Davy was no less remarkable for his courtesy to strangers than for his modesty of demeanour. Although he was attacked at various times by Gay Lussac and Thénard, by Murray, Berzelius, and other rivals, he appears never really to have lost his temper. When he had occasion to allude to his own discoveries, he always spoke of them as things which he had had the good fortune to discover. When circumstances required the application of a new name, as that of chlorine, his account of the matter was, "after consulting several eminent men I have ventured to propose this name."

INVENTION OF REVOLVING FIRE-ARMS.

It is not much more than eighty years ago since Benjamin Franklin gravely recommended his fellow countrymen, then at war with King George's troops, to return to the use of the very weapons which were employed by Ishmael the son of Abraham. Bows and arrows, he said, were very good arms, and not wisely laid aside: first, because a man may shoot as truly with a bow as with a common musket; secondly, because he can discharge four arrows in the time of charging and discharging one bullet; thirdly, because his object is not obscured from his view by the smoke of his own comrades; fourthly, because a flight of arrows seen coming upon them terrifies and disturbs the enemy's

attention to his business; fifthly, because an arrow sticking in any part of a man disables him until it is extracted; and sixthly, because bows and arrows are more easily provided everywhere than muskets and ammunition. Indeed, the struggle between bows and guns was long, and at one time seemed doubtful. Thirty thousand Frenchmen fell at Crecy, mostly pierced by the arrows and bolts of the English and of their Genoese auxiliaries; and old French chroniclers attest the terror and confusion which the English archers always produced in the enemy's ranks.

It is only within a few years past that portable fire-arms have ceased to be so clumsy and inefficient as almost to justify Franklin's preference for the old English bow. It has been said that each soldier in our wars carrying the old musket fired away his own weight in lead for every man of the enemy whom he wounded; and in the desultory warfare at Cape Colony, it was calculated that every wounded Caffre represented an expenditure of three thousand two hundred balls. So little was the musket dreaded by these savages that it was long a favourite sport with them to provoke sentries or small bodies of troops to fire upon them, and then rushing forward, to wrench their muskets from their hands; and so obvious were these tactics that the Indians in Texas, without knowing anything of the Caffres, treated their white enemies in the same way. It was in this country that the necessity for improved fire-arms was perhaps more strongly felt than in any other part of the world.

The prairie tribes of Texas ride with boldness and wonderful skill. They are so dexterous in discharging

arrows from the bow, that a single Indian, galloping at full speed, is capable of keeping an arrow constantly in the air between himself and his enemy. The American borderers have become hardy, self-reliant, and superabundantly warlike, from the necessity of maintaining their footing against such undaunted and skilful foes. Their Virginia bear-rifles and double-barrel rifles were an improvement; but the first had no advantage except its long range and spinning bullet; and the latter, although valuable for giving two chances instead of one, was very heavy, difficult to aim with, and, when once discharged, took as long to reload as two muskets. They were taught early that their great countryman's preference for the oldest weapon in the world, over the latest improved fire-arms of his days, was not so paradoxical as it seemed. They must many a time have envied the Indian his rapid and continuous discharge, and wished for a gun that would fire many balls without reloading.

Such weapons had been attempted long before in Europe, and abandoned as impracticable. There are in the Armoury of the Tower of London several guns of Indian make and of very beautiful workmanship, which are known to be as old as the fifteenth century. These guns are in principle precisely the same as the guns and pistols now known as revolvers, or repeating fire-arms; but they have serious defects. They are liable to ignite all the charges at once, and seem to have been abandoned for practical warfare as dangerous or useless. No treatises spoke of them, though there were similar specimens of British and French manufacture in the United Service Museum, and at the Rotunda at Woolwich; at

Warwick Castle, and at the Musée d'Artillerie, and the Hôtel Cluny in Paris. Even when Elisha Collier, an American gunsmith, in the year 1818, discovered the same principle, he fell into the very errors which earlier gunmakers had already remedied. Another American gunsmith in the following year patented a revolver, which was also found to be impracticable.

Colonel Colt is believed to have been the first inventor of a really available repeating pistol. Ignorant, as he declares himself to have been, of all previous attempts of the kind, and having an imperfect knowledge of mechanics, he had thought as early as the year 1829 of the possibility of making a pistol that might be fired many times without reloading. Living, he says, in a country of most extensive frontier, still inhabited by aborigines, and knowing the insulated position of the enterprising pioneer, and his dependence sometimes alone on his personal ability to protect himself and his family, he had often meditated upon the inefficiency of the ordinary double-barrelled gun and pistol; both involving a loss of time in reloading, which was frequently fatal in the peculiar character of Indian warfare. When a youth, indeed, returning from a voyage to India, he had amused himself on board the vessel in constructing a model of his idea in wood, burning out the bores with hot iron. His first device was that bundle of barrels, well known in the windows of the London gunsmiths, and which is merely a multiplied double barrel. But, in 1835—about the time when Her Majesty's Board of Ordnance were beginning to hear of percussion caps, invented thirty years previously—Colonel Colt patented in the United States a pistol on

the principle of a rotating cylinder breech, and a single barrel—a far more simple and beautiful invention, which under several modifications is now in use.

INTRODUCTION OF GUTTA-PERCHA.

The success of the submarine telegraph, which was first demonstrated in 1851, when the deep sea cable was laid down in the English Channel between Dover and Calais, entirely depended upon a single point. No submarine cable could be used for telegraphic purposes until its insulation was rendered perfect. Only one material was known to possess this insulating property, as being at the same time indestructible by water, and a bad conductor of electricity. This substance was gutta-percha, now so well known to every one in an infinite variety of forms, but which only twenty years ago had scarcely been heard of. It was in 1842 that Dr. Montgomery, an assistant surgeon to the Residency at Singapore, sauntered out one day in the neighbourhood of that city. His attention was attracted by a native woodcutter at his work, and the doctor was struck by the appearance of the hatchet which the man was using. It seemed to be both strong and flexible, and did not resemble any substance which the doctor had ever seen employed for that purpose. On questioning the man, he learnt no more than that the mysterious material could be made into any form by dipping it into

boiling water till it was heated through, when it became plastic as clay, regaining, however, when cold, its original hardness and rigidity. Struck by these facts, Dr. Montgomery inquired further, and soon discovered what he had suspected, that gutta-percha, like india-rubber, was a gummy substance which oozed out from between the bark and the wood of certain forest-trees, and that it could be had in great abundance. The great utility of such a substance in the arts at once presented itself to his mind. He obtained specimens in various stages of preparation, and sent them to the Society of Arts in London. The Society subsequently conferred a gold medal upon Dr. Montgomery. But the substance had already been seen in Europe. Even as early as the time of Charles I., the well-known botanist, Tradescant, had brought hither a specimen of this curious product, under the name of Mazer wood, and it had subsequently been often brought to Europe under the general name of india-rubber, in the form of elastic whips, sticks, etc.; but had never attracted much attention. It was in the year 1844 that two hundred-weight of this new article of commerce was shipped as an experiment from Singapore. The exportation rapidly increased. In the first four years and a half of the trade, 21,598 piculs of gutta-percha, each picul weighing about 133 pounds, were shipped at Singapore, the whole of which were sent to England, with the exception of 15 piculs to the Mauritius, 470 to the Continent of Europe, and 922 to the United States.

But this rapid growth of the new trade conveys only a faint idea of the commotion it created among the native inhabitants of the Indian Archipelago.

The jungles of the Johore were the scenes of the earliest gatherings, and they were soon ransacked in every direction by parties of Malays and Chinese, while the indigenous population gave themselves up to the search with a unanimity and zeal only to be equalled by that which made railway jobbers of every man, woman, and child in England about the same time. The knowledge of the article stirring the avidity of gatherers, gradually spread from Singapore northward as far as Penang, southward along the east coast of Sumatra to Java, eastward to Borneo, where it was found at Brune, Sarawak, and Pontianak on the west coast, at Keti and Passer on the east.

A boat made of the new substance was constructed for the expedition fitted out by Lady Franklin some years ago, to search for her brave husband and his comrades in the arctic regions. As was anticipated, it proved to be remarkably adapted for use in the ice. The gutta-percha boat belonging to the "Prince Albert" was under the charge of Mr. Snow, who has given an interesting account of the services which it rendered to the expedition. Whilst the other boats constructed of wood suffered much by the cutting of the young ice, the gutta-percha boat was found to be not in the least damaged, and returned to England in almost as good a condition as when it left, although it had performed all the rough work of the voyage. Mr. Snow adds :—

"The severest trial it endured, and endured successfully, was on both my visits to Whaler Point, Port Leopold. To those unaccustomed to the nature of such ice as was there met with, it will be impossible fully t

conceive the position a boat was placed in. The mere transit to and fro, among loose masses of ice, with the sea in a state of quiescence, would have been quite enough to have proved the value of gutta-percha boats; but when, as in the present case, those masses were all in restless agitation, with a sea rolling in upon an opposing current, it might have been well excused—and without deteriorating from the previously attested goodness of the article—if it had not been able to have resisted the severe shocks it received. Sliding through and over the ice—sometimes lifted completely out of the water by the sudden contact of a restless floe, and at others thrown sideways upon an adjoining craggy piece—I think it would have been next to impossible for any other kind of boat to have been otherwise than crushed or stoved in on the instant."

It was in commemoration of these facts, that the hardy explorers gave the name of "Gutta-Percha Inlet" to the chief scene of the gallant little boat's adventures.

JENNER, AND THE DISCOVERY OF VACCINATION.

More than fifty years before Jenner commenced the inquiries which led to his great discovery, an immense benefit had been conferred on mankind by the introduction into England of the system of inoculation, or ingrafting, as it was then called, which consisted in communicating the small-pox itself to the patient almost in the same way as the cow-pox is communicated under Jenner's system. It is difficult now to imagine the ravages committed by this fearful disease before these great discoveries. In Russia alone the small-pox is said to have swept away two millions of lives in a single year. In the family of an English nobleman, Lord Petre, during the last century, eighteen individuals were found to have died of this complaint during twenty-seven years. So fatal was the disease, that it was found at the Small-pox Hospital, where the most careful treatment was resorted to, that one in seven at least of the patients died under it, while a large proportion were in some way permanently afflicted by its destructive influence. In the London Asylum for the Indigent Blind, it was stated that three-fourths of the objects there relieved had lost their sight through small-pox.

Inoculation had long been resorted to as a preventive in Eastern countries, and was introduced here by the celebrated Lady Mary Wortley Montagu, in 1721, after her return from Turkey, whither she had accompanied her husband, then Ambassador from Great Britain. It is said that a similar practice had prevailed in some

counties of England, under the singular name of "buying the small-pox;" but it was at least considered so strange in London, that even after this remarkable lady had boldly tried it upon her two children, none but criminals, induced by an offer of pardon, could at first be found to submit to it. It was in August, 1721, that Dr. Maitland, in the presence of several eminent physicians and surgeons, performed this experiment upon three women and three men, all of whom had been condemned to death. The fact that these persons were found to receive the disease in a comparatively mild form—all of them recovering in a short time—led to further experiments; and in the following year, the Princess of Wales, afterwards Queen Caroline, wife of George II., determined that her two children, the Princesses Amelia and Caroline, should undergo the operation. All these trials having proved remarkably successful, the practice began to extend; but a number of cases soon afterwards terminating fatally, it received a serious check, and never became general.

According to Jenner's own account, it was some time before the year 1776, and therefore probably while he was practising as a surgeon and apothecary in his native village of Berkeley, in Gloucestershire, that he first began his inquiries into the nature of cow-pox; but long before this his attention had been called to the subject of the supposed effect of cow-pox in giving immunity from the more dangerous disease. Jenner, who was the son of the Vicar of Berkeley, had been apprenticed to a surgeon named Ludlow, at Sudbury, a little village near Bristol; and it was here that he was one day called upon to give medical advice to a young countrywoman,

who doubtless filled the place of dairymaid at a farm in the neighbourhood. Having casually mentioned in her presence the subject of the small-pox, the young woman immediately remarked, "I can't take that disease, for I have had cow-pox." Further inquiry showed that this was a popular notion in that part of the country; and although it was regarded by the medical profession as only a vulgar belief, it was too suggestive to be lost sight of by the surgeon's apprentice. He well knew that an eruption, chiefly showing itself on the hands of dairymaids who had milked cows similarly disordered, had attracted attention forty or fifty years before; and when he had settled down to practice as a country apothecary, he noticed that among those whom he was called on to inoculate in farm-houses, many resisted every effort to give them the small-pox. These patients, he found, had all been accustomed to milk cows, and had undergone the disease called cow-pox. His path, however, was still beset with difficulties. Few sympathized with him in an inquiry into what appeared to be merely an idle notion of the ignorant; and most persons regarded the idea of communicating to a human being a disease peculiar to a brute, as revolting, or even impious. Even the great John Hunter, in whose house Jenner, when a young man, had resided two years, paid little attention to the suggestion; and at a country medical club, of which Jenner was a member, the members denounced the whole topic as a nuisance, and sportively threatened to expel the orator, if he continued to harass them with his importunate discourse upon his favourite notion. These obstacles, however, would have been trifling, if the subject itself had not been

complex and intricate. He found, to his bitter disappointment, that numbers of those who seemed to have undergone the cow-pox, nevertheless, on inoculation under the old system introduced by Lady Mary Wortley Montagu, suffered from small-pox just the same as if no disease had been communicated to them from the cow; and all the medical practitioners in the country around him assured him that the cow-pox could not be relied on as a preventive. "This for awhile," says Jenner, "damped, but did not extinguish my ardour." Patient inquiry gradually led him to the truth, that the virus of the cow-pox underwent progressive changes, in the later of which it had so lost its specific property, that although it was capable of powerfully affecting the human body, it afforded no protection from attacks of the more serious disease.

Jenner's task was now simple. During his investigations into the nature of casual small-pox, he was naturally struck with the idea that it might be practicable to propagate the disease by inoculation, first from the cow, and finally from one human being to another. He anxiously waited for some time for an opportunity of putting this theory to the test. The first person ever vaccinated was a lad of eight years old, named James Phipps, in whose arm was inserted some of the virus, taken from the arm of a young woman who had accidentally become infected while milking a cow. On inoculating the same lad some months afterwards, Jenner found, to his great joy, that no effect could be produced—that, in fact, it was impossible to communicate to his patient the small-pox. "While the vaccine discovery was progressive," says the great and good

Jenner, "the joy I felt at the prospect before me of being the instrument destined to take away from the world one of its greatest calamities, blended with the fond hope of enjoying independence and domestic peace and happiness, were often so excessive, that in pursuing my favourite subject among the meadows, I have sometimes found myself in a kind of reverie. It is pleasant to me to recollect that those reflections always ended in devout acknowledgments to that Being from whom this and all other blessings flow."

Jenner published the account of his discovery in 1798. In spite of ridicule and opposition from many of the medical profession, and of fanatical denunciations from the ignorant, it rapidly made its way. In 1802, Jenner, who had philanthropically thrown open his secret to the world, received from Parliament a vote of £10,000. In 1807 an additional grant of £20,000 was made to this great benefactor of mankind, and he had the happiness of living to see the notion of the poor dairymaid of Sudbury accepted throughout the civilized world.

EARLY ÆRONAUTS, AND TESTU'S BALLOON VOYAGE.

The brothers Montgolfier, paper manufacturers at Annonay, about twelve leagues from Lyons, invented their well-known paper fire-balloon in 1782. After one or two experiments the present oiled silk was substituted for paper, but the principle of inflation was still that of producing rarefied air by a fire lighted under an aperture at the mouth of the balloon, exactly as in the paper balloon still sold at toyshops. In this perilous machine,

however, persons were soon found bold enough to leave the earth without the safeguard of ropes, which had previously been used. In 1783 the Marquis d'Arlandes and M. Montgolfier made the first genuine balloon ascent from Passy, near Paris, and after some alarming mishaps alighted safely in the environs of that city; but the dangerous character of these ascents, during which it was necessary to continually feed the fire under the balloon with straw carried with them by the æronauts for that purpose, soon led to the invention of the hydrogen balloon. This differed from the Montgolfier in being filled with hydrogen gas, generated by the pouring of diluted sulphuric acid on iron filings. After being long abandoned, the old dangerous Montgolfier balloon has been revived by a Frenchman, M. Godard, who very recently made a successful ascent in England with a balloon of gigantic construction inflated on that principle.

One of the earliest travellers in this improved balloon was M. Testu, whose ascent from Paris on the 18th of June, 1785, is one of the most curious episodes in the early history of balloon voyages from Paris. His balloon was twenty-nine feet in diameter, constructed by himself, of glazed tiffany, furnished with wings, and filled, as had now become the fashion, with hydrogen gas. It had been much injured by wind and rain during the night before its ascension, but having undergone a slight repair, it was finally launched with its conductor at four o'clock in the afternoon. The barometer then stood 29·68 inches, and the thermometer as high as eighty-four degrees, though the day was cloudy and threatened rain. The balloon had at first been filled

only five-sixths; but it gradually swelled as it became drier and warmer, and acquired its utmost distention at the height of 2800 feet. But to avoid the waste of gas or the rupture of the balloon, the navigator calculated to descend by the reaction of his wings. Though this force had little efficacy, yet at half-past five o'clock he softly alighted in a corn-field in the plain of Montmorency. Without leaving the car he began to collect a few stones for ballast, when he was surrounded by the proprietor of the corn and a troop of peasants, who insisted on being indemnified for the damage occasioned by his idle and curious visitors. Anxious now to disengage himself he persuaded them that his wings being broken, he was wholly at their mercy. They seized the stay of the balloon, which floated at some height, and dragged their prisoner through the air in a sort of triumph towards the village. But M. Testu, finding that the loss of his wings, his cloak, and some other articles had considerably lightened the machine, suddenly cut the cord, and took an abrupt leave of the clamorous and mortified peasants. He rose to the regions of the clouds, where he observed small frozen particles floating in the atmosphere. He heard thunder rolling beneath his feet, and as the coolness of the evening advanced the buoyant power of his vessel diminished, and at three-quarters after six o'clock he approached the ground with his car near the abbey of Royaumont. There he threw out some ballast, and in the space of twelve minutes rose to a height of 2400 feet, where the thermometer stood only at sixty-six degrees. He now heard the blast of a horn, and descried some huntsmen below in full chase. Curious to

witness the sport he pulled the valve, and descended at eight o'clock between Etonen and Varville; when, rejecting his oars, he set himself to gather some ballast. While he was thus occupied, the hunters galloped up to him. He then mounted a third time and passed through a dense body of clouds, in which thunder followed lightning in quick succession. The thermometer fell to twenty-one, but afterwards regained its former point of sixty-six degrees, when the balloon had reached an altitude of 3000 feet. In this region the voyager sailed till half-past nine o'clock, at which time he observed from his watch-tower in the sky the final setting of the sun. He was now quickly involved in darkness, and enveloped in the thickest mass of thunder-clouds. The lightning flashed on all sides, and the loud claps were incessant. The thermometer, seen by the help of a phosphoric light with which he had provided himself, stood at twenty-one degrees, and snow and sleet fell copiously around him. In this terrible situation the intrepid adventurer remained the space of three hours, the time during which the storm lasted. The balloon was affected by a sort of undulating motion upwards and downwards, owing, he thought, to the electrical action of the clouds. The lightning appeared excessively vivid, but the thunder was sharp and loud, preceded by a sort of crackling noise. A calm at last succeeded, he had the pleasure to see the stars, and embraced this opportunity to take some necessary refreshment. At half-past two o'clock the day broke; but his ballast being nearly gone, he finally descended, at a quarter before four o'clock, near the village of Campremi, about sixty-three miles from Paris.

THE VALUE OF RUSTED IRON—MR. WEISS, THE CUTLER.

About forty years ago an eminent London cutler, Mr. Weiss, of the Strand, the inventor of a number of valuable improvements in surgical instruments, observed that steel was much improved when it had become rusty in the earth, provided the rust was not factitiously produced by the application of acids. "Accordingly," says the author of the "Chronicles of Old London Bridge," to whom we are indebted for this curious anecdote, "he buried some razor blades for nearly three years, and the result fully answered his expectation. The blades were coated with rust, which had the appearance of having exuded from within; but the metal was not eaten away, and the quality of the steel was decidedly improved. It was assumed that the same principle holds good with respect to iron under similar circumstances, and with perfect confidence in the correctness of his views, Mr. Weiss determined to procure some old iron which had been subjected in an extraordinary degree to the action of rust. It happened at that time that the removal of old London Bridge offered a singular opportunity for the attainment of his purpose. The old materials were sold by auction, and among these were about fifteen tons of old iron, which the ingenious instrument-maker bid for with an eagerness which must have puzzled the other attendants of the sale, who, doubtless, regarded him as

a mere seeker of relics and curiosities. It was the iron with which the ancient piles, which had supported more than one such structure, were found to be shod, and it was supposed that they had been originally buried in the soil at the bottom of the river six or seven centuries previously. Each of these rudely-formed shoes or points consisted of a small inverted pyramid, with four straps rising from the four sides of its base, which were nailed to the pile—the total length from the point which entered the ground to the end of the strap being about sixteen inches, and the weight about eight pounds. The points of the shoes were found to be not much corroded, nor indeed were the straps; but the latter had become extremely and beautifully sonorous, closely resembling, it is said, in tone the bars and sounding pieces of an Oriental instrument which had been exhibited shortly before with the Burmese state carriage. Mr. Weiss discovered that while these straps, in addition to their sonorousness, possessed a degree of toughness quite unapproached by solid iron, the solid points had nothing to recommend them. They were convertible only into very inferior steel, while the straps, and even the bolts, which were, in fact, imperfect carburets, produced steel of a quality infinitely superior to any which in the course of his business Mr. Weiss had ever before met with. The "old pile" steel became in general request among the workmen for tools, while on the other hand they demanded higher wages, on account of its hardness, for working it. Ultimately the straps were separated from the solid points, and these last sold as old iron. At first it had been supposed, from the difference between the joints, that the shoes were composed of two sorts of iron; but

besides the improbability of this, the contrary was proved by an examination, and finally it was inferred that the extremities of the piles having been charred, the straps of iron closely wedged between them, and the stratum in which they were imbedded must have been subjected to a galvanic action, which in the course of some six or seven hundred years gradually produced the effects recorded.

THE AURORA BOREALIS AND THE TELEGRAPH.

The effect of the aurora borealis on electric telegraph lines is curious. In September, 1851, there was a remarkable aurora which took complete possession of all the telegraph lines in New England, in the United States, and prevented any business being transacted during its continuance. In February, 1852, another instance occurred. Towards evening a heavy blue line appeared upon the paper used by the operators, which gradually increased in size for the space of half a minute, when a flame of fire succeeded to the blue line, of sufficient intensity to burn through a dozen thicknesses of the moistened sheets. The current then subsided as gradually as it had come on, until it entirely ceased, and was then succeeded by a negative current (which bleached, instead of colouring the paper). This gradually increased, until it also, in turn, produced its flame of fire, and burned through many thicknesses of the prepared paper.

The effect of the aurora borealis, or magnetic storm, appears to be totally unlike that of common or free electricity, with which the atmosphere is charged during a thunder-storm. The electricity evolved during a thunder-storm, as soon as it reaches a conductor, explodes with a spark, and becomes at once dissipated. The other, on the contrary, is of very low tension, remains upon the wires sometimes half a minute, produces magnetism, decomposes chemicals, deflects the needle, and is capable of being used for telegraphic purposes, although, of course imperfectly.

The aurora borealis has in fact been used for transmitting and receiving telegraphic despatches. This almost incredible feat was accomplished in the forenoon of September 2, 1859, between the hours of half-past eight and eleven o'clock, on the wires of the American Telegraph Company, between Boston and Portland, and upon other lines in various parts of the country, as described by Mr. G. B. Prescott, the able superintendent of the American telegraph lines. The auroral influence was observed one day upon all the lines running out of the office in Boston, at the hour of commencing business (eight o'clock, A.M.), and it continued so strong up to half-past eight, as to prevent any business being done; the ordinary current upon the wires being at times neutralized by the magnetism of the aurora, and at other times so greatly augmented as to render operations impracticable. At this juncture it was suggested that the batteries should be cut off, and the wires simply connected with the earth.

The current from the aurora coming in waves of greater or less intensity, there were times, both while the

wave was approaching and while it was receding, when the instruments were enabled to work; but the time varying according to the rapidity of the vibrations, whatever business was done upon the wires during these displays, had to be accomplished in brief intervals of from a quarter to half a minute in duration.

During one of these intervals, the Boston operator said to the one at Portland, "Please cut off your battery, and let us see if we cannot work with the auroral current alone."

The Portland operator replied, "I will do so. Will you do the same?"

"I have already done so," was the answer. "We are working with the aid of the aurora alone. How do you receive my writing?"

"Very well indeed," responded the operator at Portland; much better than when the batteries were on; the current is steadier and more reliable. Suppose we continue to work so until the aurora subsides."

"Agreed," replied the Boston operator. "Are you ready for business?"

"Yes; go on," was the answer.

The Boston operator then commenced sending private despatches. The line was worked in this manner more than two hours, when, the aurora having subsided, the batteries were resumed.

SCHEMES FOR EXTINGUISHING FIRE

All who have watched the progress of inventions know how difficult it is to depend upon preconcerted experiments, as proofs of their efficacy, for attaining the results predicted by their sanguine authors. In the year 1776, a gentleman named Hartley announced that he had made a discovery which would for ever prevent those disastrous fires which had so often afflicted crowded cities. A house on fire was stated to be henceforth a thing of the past, while the parish engine and its custodians had from that time forward nothing to do but to enjoy a perpetual holiday. The accounts of this new discovery at length attracted the attention of King George III., who determined to visit the inventor at his house on Wimbledon Common, there to witness experiments illustrative of the plan. The King was accompanied by the Queen, the Prince of Wales, afterwards George IV., the Bishop of Osnaburgh, the Princess Royal, and the Princess Augusta, and several ladies and gentlemen of the court. The inventor received the distinguished party with much satisfaction, and proceeded at once to conduct them through a series of experiments which appeared to leave no doubt of the great benefits of his principle. The magazines of the time state that their majesties with the prince and princesses first breakfasted in one of the rooms; and that the tea-kettle was boiled upon a fire made upon the floor of the opposite room, which apartment they afterwards entered and saw a bed set on fire, the curtains of

which were consumed with part of the bedstead, but not the whole, the flames, from the resistance of the floor, going out of themselves. The king and queen then went downstairs and saw a horse-shoe forged in a fire made upon the floor, as also a large faggot lighted which was hung up to the ceiling. After this two fires were made upon the staircase, and one under the stairs; all which burnt out quietly, without spreading beyond the place where the fuel was first laid. The party paid the greatest attention to every experiment that was made, and expressed the utmost satisfaction at the discovery. The whole concluded by lighting a large magazine of faggots, pitch, and tar: it burnt with amazing fury, but did no damage to the floor or ceiling. It is stated that the queen and the children displayed the utmost courage and composure in going upstairs and remaining in the room immediately over that which was raging in flames beneath.

Mr. Hartley's plan, notwithstanding these apparently triumphant experiments, never became generally adopted, and is forgotten. It must be remembered that the inventor in conducting experiments of this kind is enabled to select all the conditions of the trial and to avoid difficulties which might occur in ordinary practice. Probably this is the reason why so little has been heard of late years of a kindred invention, Phillips's fire annihilator, the success of which appears to be still more completely demonstrated. About fifteen years ago, scientific men and public writers were invited to witness the effective power of this new invention for extinguishing fires. A numerous party accordingly assembled at the London gas-works, Vauxhall. The agent

by which it was sought to accomplish the object was a mixture of gas and vapour. After several experiments on a small scale, to show the success attained by these means, the attention of the company was directed to a compartment of a large open building, quite twenty feet high inside, which was fitted up with partitions and temporary joisting of light wood, well soaked with pitch and turpentine, and overhung beside with rags and shavings soaked in the like manner. The torch was applied to this erection, and the flames, which ascended immediately, at length roared with a vehemence which drove the spectators back to a distance of forty feet, and were already beyond the power of water. The inventor then brought forward one of his hand-machines, and threw out a volume of gaseous vapour, which in half a minute entirely suppressed all flame and combustion; and to show that the vapour which now filled the space was quite innoxious, Mr. Phillips mounted into the loft, and passed and repassed through the midst of it with a lighted candle in his hand. The machine with which this effect was accomplished was rather larger than a good sized coffee-pot, and consisted of three tin cases, one within another, and mutually communicating. There was a small quantity of water in the bottom of the machine, and in the centre case was a composite cake, of the size and colour of peat—containing in the middle of it a phial of sulphuric acid and chlorate of potash. In order to put the machine into action this phial was broken, and a gaseous vapour generated so rapidly and in such quantity that it immediately rushed out from a lateral spout with great impetuosity. The inventor explained that a machine of

any size could be made according to the purpose for which it was intended.

There can be no doubt that all these experiments were honestly conducted, and did really effect what they appeared to do; but nevertheless, great fires continue their destructive ravages, and the various fire brigades are, unhappily, not yet enabled to retire from their labours.

THE MODERN THIEF-CATCHER.

THERE can be no doubt that nothing has contributed more to render robbery a difficult and dangerous profession than the invention of the electric telegraph. The following curious entries appear in the telegraph book, preserved at the Paddington Station :—

"Paddington, 10.20 A.M.—Mail train just started. It contains three thieves, named Sparrow, Burrell, and Spurgeon, in the first compartment of the fourth first-class carriage."

"Slough, 10.50 A.M.—Special train just left. It contained two thieves: one named Oliver Martin, who is dressed in black, crape on his hat; the other named Fiddler Dick, in black trousers and light blouse. Both in the third compartment of the first second-class carriage.

"Slough, 11.16 A.M.—Special train arrived. Officers have taken the two thieves into custody, a lady having lost her bag, containing a purse with two sovereigns

and some silver in it; one of the sovereigns was sworn to by the lady as her property. It was found in Fiddler Dick's watch-fob."

It appears that, on the arrival of the train, a policeman opened the door of the third compartment of the first-class carriage, and asked the passengers if they had missed anything. A search in pockets and bags accordingly ensued, until one lady called out that her purse was gone. "Fiddler Dick, you are wanted!" was the immediate demand of the police-officer, beckoning to the culprit, who came out of the carriage, thunderstruck at the discovery, and gave himself up, together with the booty, with the air of a completely beaten man. The effect of the capture so cleverly brought about is thus laconically entered in the telegraph book:—

"Slough, 11.51 A.M.—Several of the suspected persons who came by the various down-trains are lurking about Slough, uttering bitter invectives against the telegraph. Not one of those cautioned has ventured to the Montem."

Another instance may be cited:—

One night, at ten o'clock, the chief cashier of the Bank of England received a notice from Liverpool, by electric telegraph, to stop certain notes. The next morning the descriptions were placed upon a card and given to a proper officer to watch that no person exchanged them for gold. Within ten minutes they were presented at the counter by an apparent foreigner, who pretended not to speak a word of English. A clerk in the office who spoke German interrogated him, when he declared that he had received them on the Exchange at Antwerp, six weeks before. Upon reference to the books, however, it appeared that the notes had only

been issued from the bank about fourteen days, and therefore he was detected at once as the utterer of a falsehood. An officer was sent for, who forthwith locked him up, and the notes were detained. A letter was at once sent to Liverpool, and the real owner of the notes came up to town. He stated that he was about to sail for America, and that whilst at an hotel he had exhibited the notes. The person in custody advised him to stow the valuables in his portmanteau, as Liverpool was a very dangerous place for a man to walk about in with so much money in his pocket. The owner of the property did so, but had no sooner left the house than his adviser broke open the portmanteau and stole the property. The thief was taken to the Mansion House, and could make no defence. The sessions were then going on at the Old Bailey. By a little after ten the next morning, such was the speed, not only was a true bill found, but the trial by petty jury was concluded, and the thief, thanks to the invention of the telegraph, sentenced to expiate his offence by ten years' transportation.

A READY-WITTED INVENTOR.

Although the elder Brunel left France very young, and resided in America some years before he came to England, he never completely overcame the difficulties of the English language. His accent indeed was far from faultless, but he had a ready command of words, and no

difficulty in expressing himself in an emergency. His daughter relates that when the Prince Regent, afterwards George IV., visited the works at Woolwich which Brunel had erected, he addressed the engineer with the words, "*I* remember Mr. Brunel perfectly, but Mr. Brunel has forgotten *me*." The latter bowed respectfully, and expressed his regret that he had been guilty of any omission. "The fact is," continued the Prince, "that some years ago, when you explained to me the block machinery at Portsmouth, you promised me a copying machine of your invention, but you forgot your promise, Mr. Brunel." Without any hesitation, the engineer, who was probably not displeased to have been so well remembered, replied, "Please your Royal Highness, I have never been able to perfect the machine so as to make it worthy of your acceptance." The very first patent he had taken out was for a duplicate writing and drawing machine, which was probably the invention referred to by the Prince: it was not till upwards of twenty years later that Brunel took a patent for his copying press, which was more successful.

On another occasion, when Brunel had to give evidence in a court of justice in a cause relating to a patent right, it was absurdly attempted to throw discredit on his testimony because he was a foreigner. Are you not a Frenchman, *Monsieur* Brunel?" asked the opposing counsel, with a triumphant glance at the gentlemen of the jury. "Oh, yes," replied the witness coolly; "I am from Normandy, the country from which your oldest nobility derive their titles."

Some gentlemen having applied to him to make a variety of machinery for applying a small water power

to sawing wood, cutting stone and marble, preparing oak-bark, etc., they expressed a hope that he would not think their notions extravagant or ridiculous. Brunel replied, "I see nothing ridiculous in your attempting to adapt a small power to many purposes—no more than to have many carts and only one horse. It is not expected you will fasten them all together when you only want the use of one."

THE GEOLOGIST AND HIS HORSE.

Unlike William Smith, the "father of English geology," who being too poor to ride except when employed as a land-drainer, walked over a large part of England, the late Dr. Buckland had means to mount, and performed nearly all his geological excursions on horseback, the horse imbibing a decidedly geological taste. The doctor rode a favourite old black mare, who was frequently caparisoned all over with heavy bags of fossils and ponderous hammers. The old mare soon learnt her duty, and seemed to take interest in her master's pursuits; for she would remain quiet without any one to hold her, while he was examining sections and strata, and then patiently submit to be loaded with interesting but weighty specimens. Ultimately, she became so accustomed to her work, that she invariably came to a full stop at a stone quarry, and nothing would persuade her to proceed until the rider had got off and examined the

quarry. On one occasion Dr. Buckland was in some danger from the falling stones as he was climbing up the side of one of these quarries. He was told of his danger by the bystanders. "Never mind," said he, "the stones know me."

A STORY OF THREE WORKMEN.

A GREAT fire, which broke out in Paris in 1802, entirely destroyed the magnificent grain market, the cupola of which was regarded as one of the most remarkable structures in Europe, not merely for its vast dimensions, but for the novelty and ingenuity of the principle on which it was constructed. This cupola was entirely the work of three somewhat obscure artizans, whose names are scarcely remembered in history beyond the following anecdote:—At the time of the *fêtes*, given in Paris in honour of the birth of the dauphin son of Louis XVI., the great space enclosed by the circular building then known as the Halle aux Blés, was covered by an immense awning, presenting by the light of the illumination within a beautiful appearance. This sight made a powerful impression upon the imagination of two young architects, named Legrand and Molinos, who had recently returned from studies in Rome, one of whom remarked that it was a pity such a roofing could not be made permanent. The idea reached the authorities, who at once requested the young architects to undertake the task.

"It is impossible," replied Molinos. "This vast building, with its twenty-five arcades, was designed by the famous Mezières, without any idea of its being called upon to support the enormous weight of such a roof as would be required."

"Nothing is impossible for genius," interrupted Legrand. "I know an enthusiastic workman, a mere joiner but a good mathematician, who would find some way to solve the problem. He has published a book about the joiner's art, and though few pay attention to him, he is one of the most able and original men of his time."

This man was the builder, Jacques Roubo, and the young architects lost no time in presenting their request to him.

"I care nothing for the reputation of originality," said Roubo, after listening respectfully to his visitors' statements. "My originality shall be simply that of having the courage to revive a plan which has been long forgotten, and which I think will accomplish what appears to you so difficult. Give me a day, and I will give you an answer."

On the following day Roubo made known his determination to undertake the construction of the cupola, on the conditions that he should be at liberty to select his own workmen, and should have entire freedom to follow his own plans. This being assented to, he devised a plan suggested by the Chateau de la Muette, constructed by the celebrated Philip Delorme, which consisted in substituting for solid beams thin boards supporting each other, and going off from the edges of the walls in all directions. He had to help him in his difficult task

a carpenter named Albourg, and a blacksmith named Raguin, the latter of whom executed the fine iron lanthorn which formed the crowning point in the edifice. After only five months of labour, so well directed that not one human life was risked, the great work was completed on the 31st of January, 1783. The cupola was one hundred and twenty feet in diameter, its height being one hundred feet from the ground. Twenty-five openings filled with panes of glass divided the roof from top to bottom, and it appeared to the architects of the time almost impossible to conceive how the dome was sustained, divided as it was between wood and glass, and apparently of less than one foot in thickness. When the temporary supports were finally taken down, Roubo, full of confidence in the principle which had guided him, insisted on standing under a cornice, in order to examine the roof closely, and observe if it shook when left to its own resources. No one would share with him what everybody considered a great danger. The props were removed amid the acclamations of the people, and the intrepid Roubo was assured of the complete success of his undertaking. He was borne in triumph on the shoulders of the admiring citizens, the crowd pressing on all sides to gain a sight of the man to whom they owed a construction so novel.

Roubo, on this occasion, as well as on all others, showed himself to be as disinterested as he was skilful, renouncing what he might have claimed as originator of so great an enterprise, and accepting only the sum agreed upon as a remuneration for directing the work. Raguin, praising his own lanthorn one day to him, Roubo replied, "Don't mention it;

if I were only in your line, I would have made the whole cupola of iron" — an idea realized twenty-five years afterwards. Roubo's history is interesting. The son of a poor journeyman builder, he had been left to himself at an early age; nevertheless, endowed with a strong desire to raise himself above the circumstances in which he was placed, and conscious that improvement alone would do this, he applied himself diligently to study, although many difficulties stood in the way. The little money given him to buy food was for the most part laid out in the purchase of books and models for drawing; the harshest privations were unheeded by him, if he could buy books. When he began to work at his father's trade, he was still so poor, that when he sat up during the long winter nights for purposes of study he could not afford to pay for a lamp or candle, and was obliged to pick up pieces of tallow and fat thrown out by the neighbours and burn them. Such ardour did not remain long unfruitful. He was observed by Professor Blondel, a nephew of the celebrated architect of that name; and, from that time, he had a guide and a support. After giving him gratuitous lessons for five years, and otherwise encouraging and assisting him, Blondel had cause to be proud of his pupil.

THE STRUGGLES OF OPTICAL-GLASS—GUINAND OF BRENETS.

The first artists and men of science on the Continent had failed in manufacturing glass exactly suited to the purpose of optical instruments, when about the middle of the last century Dollond and the French and German opticians made experiments to discover the cause of this failure. They found it to be the necessity for avoiding any variation in the media of which the glass is composed; as the slightest difference acted as a disturbing cause to the progress of the ray of light, deranging the refraction and distorting the object. The Academie des Sciences in Paris offered prizes in vain for the overcoming of this difficulty. The celebrated chemists, Roux of St. Gobain, and Anut of Langres, devoted their attention to it in vain; even when partially successful, a diameter of three inches or three inches and a half was the largest they could obtain. It remained for a man in no degree conversant with science, not a glass maker by trade nor distinguished by education, but endowed with wonderful energy, spirit of inquiry, and perseverance to arrive at the solution of the difficulty.

This man was Guinand, a poor peasant in the village of Brenets, in the canton of Neufchatel in Switzerland. Like many of the villagers in Switzerland, Guinand partly employed his time as a workman in a branch of the watch trade. Watchmaking, from the necessity of continual close inspection with a magnifying glass into

minute portions of the work is proverbially injurious to the eyes; and Guinand, suffering from the common affliction of his trade, was compelled to wear spectacles. His poverty—for the earnings of the Swiss watchmakers were at this period extremely low—drove him to the resource of grinding spectacle-glasses for his own use. In this way he acquired some practical knowledge of the principle of lenses. Being of a very ingenious turn of mind the work interested him, and he began to make for his own amusement small refracting telescopes, which he mounted in pasteboard cases. One day visiting the shop of Droz, the master who employed him, at Chaux de Fonds, he was shown a small achromatic telescope of English manufacture, a more perfect instrument than he had ever seen before. Delighted with the object he obtained permission to examine it, and finally to take it to pieces, separate its lenses, and measure its curves. Satisfied that he had mastered the principle, Guinand resolved to attempt to imitate it, and communicated the intention to his master. Glass suited to the purpose could only be obtained in England; Droz, having occasion to visit this country to obtain a patent for his self-winding watches, brought back with him as much glass as enabled Guinand to construct several achromatic telescopes, which were entirely successful.

There was, however, still the great difficulty of bad glass, and the presumed impossibility of procuring optical glass of a large size. Even Sir Isaac Newton had pronounced these difficulties insurmountable. How, then, was a humble journey-worker to succeed in overcoming them? The question seemed unanswerable, but Gui-

nand was in no way daunted. He had been accustomed to the fusing of metals in his own business, and had observed that in the ordinary process the waving and the threads similar to those seen in the fusing of glass were removed by stirring and thoroughly mixing the metal by means of an iron bar. This fact suggested the application of the same process to flint glass, and after many attempts made during his leisure hours the ingenious peasant succeeded in what had so long baffled the great scientific men of his time, the production of flint glass perfectly free from what are called striæ. From 1784 to 1790 he made almost daily experiments, melting down at each time about three or four pounds of glass, and keeping a careful record of all the facts which he observed. Having during this time abandoned his old branch of the watch trade for a more profitable one he obtained a better command of capital and leisure, and among the first results of his improved circumstances he purchased a piece of land on the banks of the Doubs, where he constructed a furnace capable of fusing the large amount of two hundred weight of glass. Accidents and disasters long beset his course. His crucibles failed, his furnaces burst, but he renewed them, and repaired all defects with indomitable patience. At last he succeeded in obtaining large pieces of uniform quality, in one case reaching the size of eighteen inches in diameter. He also discovered the important art of soldering together pieces of good glass, altogether obliterating the line of junction. This he accomplished by first fusing them together, and then grinding out the globules of air or particles of sand on a wheel dusted with pow-

dered emery. Finally, he replaced the mass in a furnace, when the glass expanding and filling up the hollows, he was enabled to obtain with certainty the discs of flint glass larger than any that had yet been manufactured.

M. Utzschneider, of Munich, hearing the result of his experiments, on making further inquiry, proposed to him to join him and M. Frauenhoffer in their establishment at Munich; he accepted the offer, and one of the largest glasses resulting from their experiments is now in the Observatory at Dorpat.

Guinand returned to his own country, but not being a glass-maker by profession, he prosecuted his researches only at intervals. He had discovered the principle; had earned a well-merited reputation in the world of science, and promoted the researches of others; but the results of his experiments had not attained to certainty in practice, and he had not overcome the difficulties in the fabrication of crown-glass, which requires the same perfection and the same dimensions as the corresponding flint.

In the latter years of his life, Guinand entered into communication with the Astronomical Society of London, and sent over some discs of flint-glass, of which Messrs. Dollond, Herschel, and Pearson made a favourable report. It is remarkable that at this time, in the country which had supplied the Continent with flint-glass, a disc of six inches should have been considered a rarity.

Soon after, a commission, composed of Messrs. Herschel, Faraday, Dollond, and Roget, was instructed to pursue the inquiry as to the manufacture of flint-glass.

Mr. Faraday took the lead, both in his own laboratory and at the glass-works of Messrs. Pellatt, and could not fail of arriving at important conclusions. He changed the principle of fabrication, and produced a borate of lead of remarkable purity. The Lords of the Treasury had found it advisable to make a relaxation of the Excise laws in favour of the Royal Society, or persons acting for scientific purposes under that body. But, notwithstanding this regulation, the interference of the officers, and the delay in obtaining the necessary licence, proved so onerous and inconvenient, as completely to shackle their proceedings, and preclude all attempt to improve by means of experiment: and the question as to the fabrication of flint-glass being actively pursued in France and Switzerland, the Commission ceased from its labours.

Shortly afterwards M. Guinand died, bearing with him the secret of his process; but in Bavaria, the works in which he had taken part had been continued according to his system; and his wife and two sons had witnessed his experiments, and were desirous of availing themselves of their father's invention for their own advantage.

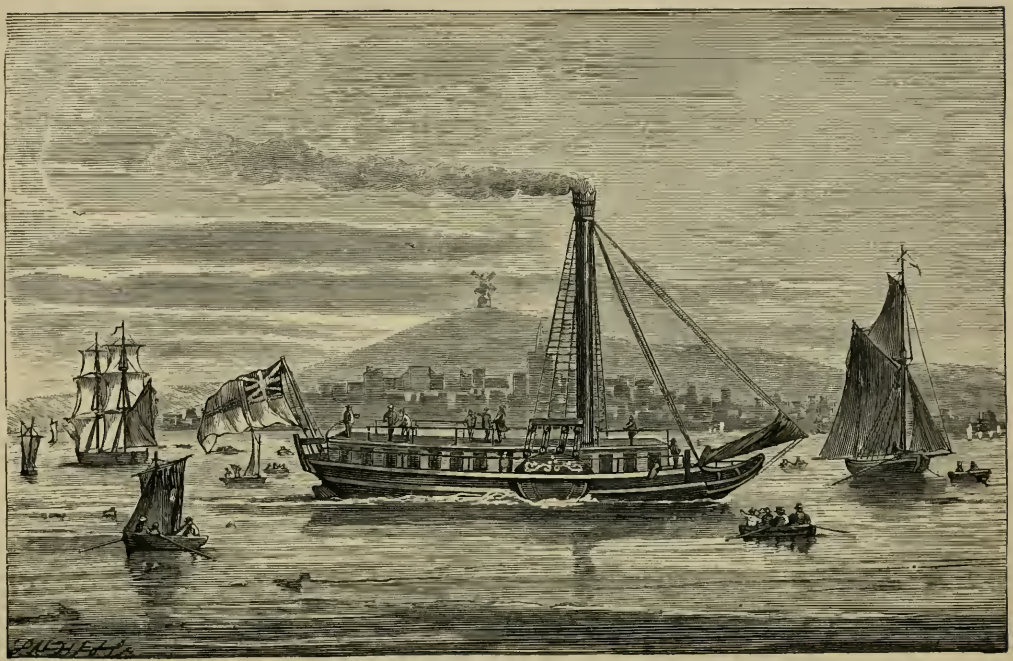
M. Bontemps, who had devoted much attention to the manufacture of glass generally, and particularly of such as is required for optical purposes, was introduced by M. Lerebours, of Paris, to one of the sons of Guinand, who was endeavouring to sell his father's secret in England, or in France. He formed an association with him, but did not succeed in arriving at any good result. The treaty was broken; but M. Bontemps, satisfied of the correctness of the principle if properly

applied, continued the experiments at his works without excluding Guinand; and in 1828 they succeeded in producing good flint-glass, and discs of from twelve to fourteen inches, besides a large quantity of smaller sizes. From that time the manufacture may be considered to have been established on a regular system. Pure discs of flint-glass were exhibited in the Great Exhibition of 1851, of twenty-nine inches in diameter, each weighing the enormous amount of two hundred weight.

GALVANI AND THE FROG.

Galvani, a natural philosopher of Bologna, in Italy, was one day dissecting a dead frog while one of his pupils happened to be making experiments in electricity by his side. He observed that the muscles of the frog being exposed gave signs of motion whenever the nerves came in contact with the scapel, which acted of course as a metallic conductor. Galvani varied his experiments and dissected another frog, exposing the nerves which go down the spine into the legs, and wrapping them in a leaf of pewter. He applied to this one of the two points of a compass or a pair of scissors, and touched with the other the surface of the leg or thigh of the frog. Every time this was repeated it produced convulsive movements in the muscles, which were motionless when the process was repeated without communication with the pewter leaf. Galvani, who was a man of great in-

telligence, discovered the existence of a new principle in this phenomenon, and originated the fertile branch of physics known by the name of Galvanism. The convulsions observed by him in frogs were not permanent, and could only be produced by contact with an instrument formed of two metals. After numerous experiments he discovered that a metallic communication must be established between the nerves and the muscles. Thus was the galvanic fluid, Nature's most powerful agent in all her operations on the surface of the globe, made known to man. Shortly afterwards, Volta, another philosopher, repeated Galvani's experiments, and discovered that electricity was developed by the mere contact of metals; and conceived the idea of constructing what has since, from the name of the inventor, been called the Voltaic pile. The quantity of electric fluid produced by the first contact of zinc, copper, and cloth, communicated itself to the second, and so on increasing with great energy as it accumulated to the end of the pile. The chemical effects of this instrument he found to be very remarkable; it decomposed water, oxides, acids, and all salts. The chief merit of Volta's discovery was that it demonstrated the fact that the principle of the phenomena observed by Galvani was in the metals themselves, and not in the nerves of the animal. In short, the cause of the movements he had noted was simply a current of electricity passing along the nerves and muscles. This gave rise to the term Voltaic Electricity, and finally led to the perfecting of the electric telegraph.



THAMES STEAM BOAT IN 1814.

THE PIONEERS OF STEAM NAVIGATION.

The idea of moving a vessel in the water by means of paddle-wheels, appears to be of great antiquity. The boats by which the Roman army under Claudius Codex was transported into Sicily were propelled by wheels moved by oxen; and in many old military treatises the substitution of wheels for oars is mentioned. One of the earliest of the dreams of our own inventors was that of making ships move by mechanical power, and without the assistance of wind and tide, and many ingenious designs were published professing to accomplish that object. Thomas Savery obtained a patent in 1696 for a paddle-wheel to be fixed on each side of a ship, to be turned by men by means of a capstan. Papin, Jonathan Hulls, Bernouilli, and others, also suggested schemes foreshadowing the use of steam in navigation; but all these notions were fruitless, before the invention of a steam-engine producing a continued rotative or circular motion fitted to turn the paddle-wheels with the necessary force. Six years after Watt took out the patent for his sun and planet motion, Mr. Patrick Miller, of Dalswinton, published a pamphlet detailing a plan for propelling a double sailing boat, invented by him, by means of paddle-wheels; but the motive power he proposed to employ at that time, was simply the tedious one of men turning a capstan. Several experiments with this kind of vessel were tried, but the men were found to become too much exhausted with the labour of turning the capstans o

render the scheme profitable. It was during a conversation on the subject of these experiments at the house of Mr. Miller at Dalswinton, in the year 1787, that Mr. James Taylor, a gentleman living in Mr. Miller's family as tutor to his sons, suggested the substitution of the newly-invented steam-engine for the rude contrivance of manual labour. Mr. Miller appears to have been at first disinclined to adopt the suggestion, on the ground that when chiefly wanted to give aid, that is to say in time of storms, it would prove useless; Mr. Miller adding, "In such cases as that disastrous event which happened lately of the wreck of a whole fleet upon a lee shore, off the coast of Spain, every fire on board must be extinguished."

Fortunately, however, it was determined to try the experiment. "At this time," says Mr. Taylor, in his narrative of this affair, "William Symington, a young man employed at the lead mines at Wanlockhead, had invented a new construction of the steam-engine by throwing off the air pump. I had seen a model work and was pleased with it, and thought it very answerable for Mr. Miller's purpose. Symington had come into Edinburgh that winter for education; being acquainted with him I informed him of Mr. Miller's intentions and mine, and asked if he could undertake to apply his engine to Mr. Miller's vessels, and if he could I would recommend him. After some conversation Symington engaged to perform the work, and Mr. Miller agreed to employ him. It was finally arranged that the experiment should be performed on the lake at Dalswinton in the ensuing summer (1788). Accordingly, in the spring after the classes of the college broke up, I re-

mained in town to superintend the castings, etc., which were done in brass by George Watt, founder, at the back of Shakspeare Square. When they were finished I sent the articles to the country and followed myself. After some interval I took Symington with me to Dalswinton to put the parts together. This was accomplished about the beginning of October, and the engine, mounted in a frame, was placed upon the deck of a very handsome double pleasure boat upon the lake. We then proceeded to action, and a more completely successful and beautiful experiment was never made by any man, at any time, either in art or science."

The boat was composed of two small deck boats placed side by side, and joined together according to a plan which was believed by Mr. Miller to secure greater speed and other advantages. The vessels were only twenty-five feet long, and seven broad, and the tiny engine, the cylinders of which were only four inches in diameter, was placed upon a platform between the two boats, which it was found to move easily along at the rate of five miles an hour. The experiment was repeated shortly afterwards with another boat and a speed of six and a half or seven miles an hour having been obtained, a narrative of the experiments was drawn up by Mr. Taylor and published in the *Caledonian Mercury* and other papers. Small as was the scale on which these experiments were conducted, they demonstrated for the first time the possibility of moving a vessel continuously without the aid of, and even in opposition to, wind or tide. Mr. Miller was not unaware of the stupendous results to be anticipated from such an invention; but the kind of engine employed was regarded

by him as not adapted for the purpose of practical steam navigation. The experiments were suspended, and after amusing themselves for a few days on the lake with the first steamboat ever employed, the inventors removed the engine employed in the original experiment and carried it into the house of Mr. Miller where it remained an ornamental piece of furniture for many years.

It is, in fact, as satisfactorily shown by Mr. Bennet Woodcroft, to the perseverance of the young mechanic employed at the lead mines at Wanlockhead, that we owe the construction not of a mere philosophical toy but of a really practical steamboat. In the year 1801 Thomas, Lord Dundas, of Kerse, having heard of the Dalswinton trials, employed Mr. Symington to make a series of experiments on steamboats with a view to enable them to be substituted for the horses then employed to draw vessels on the Forth and Clyde canal. These experiments occupied more than two years, and are said to have cost more than seven thousand pounds. The result of these efforts was the construction of the "Charlotte Dundas," so named from his lordship's daughter—"a vessel," says Mr. Woodcroft, "which from the simplicity of its machinery, might have been at work to this day with such ordinary repairs as are now occasionally required to all steamboats." In this vessel there was an engine with the steam acting on each side of the piston (Watt's patented invention), working a connecting rod and crank, Pickard's patent, and the union of the crank to the axis of Miller's improved paddle-wheel, which was Symington's own invention. Thus had Symington combined together for the first time, those improvements which constitute

the present system of steam navigation. Having a number of noblemen and gentlemen aboard, and towing two vessels each of seventy tons burden, the "Charlotte Dundas" moved easily for nineteen miles and a half in the face of a strong gale which prevented any other vessel being even towed by horse power to windward that day. Although an objection was raised on account of the damage done to the banks by the waves created by the paddles, the Duke of Bridgewater gave an order to Symington to build eight boats similar to the "Charlotte Dundas" to ply on his canal. It is stated that Symington returned to Scotland elated with the prospect of being able to introduce steam navigation in a short time, and to realize to himself the advantages which his ingenuity and unwearied perseverance gave him reason to anticipate; but he was doomed to disappointment, for on the same day that he was informed by Lord Dundas of the final determination of the committee not to allow steamboats to be employed on the canal, he received intelligence of the death of the Duke of Bridgewater. Unable longer to struggle against his misfortunes, his resources being exhausted, he was obliged, with great reluctance, to lay up his boat in a creek of the canal, where it remained for a number of years exposed to public view.

Mr. Taylor's widow subsequently received a pension from the government, granted by the late Lord Liverpool, and in 1837 each of his four daughters received a gift of £50 through Lord Melbourne. Mr. Miller, who was a wealthy man sought no pecuniary aid. On the whole it cannot be said that the pioneers of steam navigation received rewards from the state commensurate with

the great services which they rendered to the world. Symington presented a memorial to the Lords of the Treasury in 1825, in consequence of which the sum of one hundred pounds was awarded to him from Her Majesty's privy purse, and a year or two afterwards a further sum of fifty pounds; but in the decline of his life he was chiefly supported by a trifling sum allowed him by the steamboat proprietors, and by the assistance of a few relatives and friends.

The year 1812 is memorable as the year in which a practical steamboat was first constructed to ply for hire. This was the "Comet" steam passage boat, designed by Mr. Henry Bell, of Helensburgh. It was a vessel of thirty tons burden, only propelled by a steam engine driving two paddle-wheels on each of her sides. The engine was estimated at three-horse power. Having built and launched this vessel on January 18, 1812, Mr. Bell exhibited the following placard on the 5th of August in that year:—

"Steam Passage Boat the 'Comet,' between Glasgow, Greenock, and Helensburgh, for passengers only.

"The subscriber having, at much expense, fitted up a handsome vessel to ply upon the river Clyde, between Glasgow and Greenock, to sail by the power of the wind, air, and steam, he intends that the vessel shall leave the Broomielaw on Tuesdays, Thursdays, and Saturdays, about mid-day, or at such hour thereafter as may answer from the state of the tide; and to leave Greenock on Mondays, Wednesdays, and Fridays, in the morning, to suit the tide. The elegance, comfort, safety, and speed of this vessel require only to be proved to meet the

approbation of the public; and the proprietor is determined to do everything in his power to merit public encouragement. The terms are, for the present, fixed at four shillings for the best cabin, and three shillings the second; but beyond these rates nothing is to be allowed to servants, or any other person employed about the vessel. The subscriber continues his establishment at Helensburgh Baths, the same as for years past, and a vessel will be in readiness to convey passengers to the 'Comet' from Greenock to Helensburgh. Passengers by the 'Comet' will receive information of the hours of sailing by applying at Mr. Houslen's Office, Broomielaw; or Mr. Thomas Blackney's, East Quay Head, Greenock.

"HENRY BELL."

Mr. Bell's enterprise and speculation for the first year turned out a losing one; for so great, says he, was the prejudice against steam-boat navigation by the hue and cry raised by the fly-boat and coach proprietors, that for the first six months very few would venture in her. But in the course of the winter of 1812, as she had plied all the year she began to gain credit; as passengers were carried twenty-four miles as quick as by the coaches and at a third of the expense, besides being warm and comfortable. But even after all, he was a great loser that year. In the second year, he made her a jaunting boat all over the coasts of England, Ireland, and Scotland, to show the public the advantage of steam boat navigation over the other mode of sailing.

Two years after the launching of the "Comet," Mr. George Dodd, an enthusiastic engineer and designer of steamboats, successfully navigated a new vessel named

the "Majestic," from Port Glasgow in Scotland to Dublin, and thence round the Land's End in Cornwall to the Port of London. It was chiefly owing to Mr. Dodd's exertions that steam vessels were regularly established on the Thames in the year 1814. In 1817 five of these vessels were plying for passengers under Mr. Dodd's directions; two between London and Richmond, two between London and Gravesend, and two between London and Margate. A large number of serious accidents by fire and the bursting of the boilers of the high pressure engines then in use, led to a Parliamentary inquiry in 1817; but in spite of adverse witnesses and the organized opposition of the Thames watermen, the cause of steam navigation rapidly gained ground, and the committee inserted in their report the following memorable words:—

"Your committee entered on the task assigned them with a strong feeling of the inexpediency of legislative interference with the management of private concerns or property, farther than the public safety should demand, and more especially with the exertions of that mechanical skill and ingenuity, in which the artists of this country are so pre-eminent, by which the labour of man has been greatly abridged, the manufactures of the country carried to an unrivalled perfection, and its commerce extended over the whole world.

"Among these, it is impossible for a moment to overlook the introduction of steam as a most powerful agent, of almost universal application, and of such utility, that but for its assistance, a very large portion of the workmen employed in an extensive mineral district of this kingdom, would be deprived of their subsistence.

"A reference to the evidence taken, will also show with what advantage this power has lately been applied, in Great Britain, to propel vessels both of burthen and passage; how much more extensively it has been used in America, and of what farther application it is certainly capable, if it may not be said to be even now anticipated in prospect."

THE HUMOROUS SIDE OF TELEGRAPHY.

The despatches which pass over a telegraph line, says a practical manager of an extensive system of telegraphy, if collected together, would present a very curious and interesting volume of correspondence. The price of the transmission of a message depending upon the number of words which it contains, of course renders the construction of it necessarily as brief as possible. Most despatches are contained in less than ten words (exclusive of address and signature, which are not charged for), and it is surprising how much matter is often contained in this brief number.

A lady, desirous of ascertaining when her husband would return home, sent him a message making the inquiry; to which he responded, that important business detained him, and that he could not leave for some days.

The lady immediately replied by sending him another despatch in the following laconic manner:—

"*At home, August* 12, 1859.

"To F. C. P.—Despatch received. Deuteronomy xxiv. 5. "(Signed) KATE."

The gentleman to whom the despatch was addressed, upon referring to the passage in the Scriptures alluded to, obtained the following lengthy and suggestive epistle:—

"When a man hath taken a new wife, he shall not go out to war, neither shall he be charged with any business: but he shall be free at home one year, and shall cheer up his wife which he hath taken."

The second example is a reply sent to a person who, having committed some offence against the laws, and run away, was desirous of ascertaining if it would be prudent for him to return. He therefore telegraphed in the following laconic style:—

"*July* 4, 1859.

"To B. C. M.,—Is everything O. K.?

"D. T. M."

To which he obtained the following brief reply:—

"*July* 4, 1859.

"To D. T. M.,—Proverbs, chap. xxvii. 12.

"B. C. M."

Upon reference to the passage indicated, the inquiring individual obtained the following valuable advice, which, it is to be presumed, he followed:—"A prudent man foreseeth the evil, and hideth himself; but the simple pass on, and are punished!"

THE HISTORY OF PAPER-HANGINGS.

Flock paper-hangings were first manufactured in England, and invented by Jerome Lanyer, who obtained a patent in the reign of King Charles I., and carried on

his art in London. In this patent it is stated, that by his endeavours he hath found out an art and mystery of affixing wool, silk, and other substances, with oil, size, and other cements, to make them useful for hangings and other occasions, which he calleth Londriniana; and that the said art is of his own invention. M. Savary, in his "Dictionary of Commerce," 1720, says that flock-hangings were first made at Rouen, but in a coarse manner, being only used for grounds, on which, with flocks of different kinds, were formed designs of brocades. They essayed to imitate tapestry-hanging, but not satisfactorily; and at last a manufactory was established at Paris, in the Faubourg St. Antoine, and there flowers and grotesques were introduced with success. His descriptions, detailing the manufacture of flock-hangings, do not allude to the use of paper as a ground, nor to blocks for printing. A French author, writing in 1723, says that paper-hangings, called tapestry in paper, were, till lately, only employed by the country people for their cottages, or by small tradesmen in their shops or rooms; but towards the end of the seventeenth century, the manufacture was raised to such a point of perfection and beauty, that, besides the quantities that were exported abroad, and to the principal cities of the kingdom, there was scarcely a house in Paris not decorated with it. In England this manufacture continued from the time of Lanyer, and obtained a high reputation.

In 1712, a duty of $1\frac{1}{2}d.$ per square yard was imposed; and a Mr. Jackson, who established a factory at Battersea for paper-hangings of classic design in chiaro-oscuro, wrote, in a work published in 1754, in

praise of his own productions, and condemning the fanciful paper-hangings at the time so much used, comparing them with the Chinese. In the year 1786, there was established at Chelsea a manufactory for paper-hangings of a very superior description, by George and Frederick Echardts. Works excelling even those of the present day were produced at this place. Some of the blocks used still exist, which are said to have great merit in the designs, and are, some of them, eight feet in length. These manufacturers carried the art to its highest point in England: they printed not only on paper, but also on silk and linen, and employed a number of artists, in addition to workmen and children. The discovery of how to make paper in continuous lengths, and the repeal of the paper duty, have since then converted this once luxurious decoration into an almost universal covering for walls.

A GREAT INVENTOR'S RECREATIONS.

It is remarkable that the designer of the Thames Tunnel, whose name is identified with gigantic undertakings, was also the inventor of some of the most beautiful and delicate machines which have delighted the visitors to our great exhibitions. Many loiterers at South Kensington in 1862 stopped before a neatly dressed young woman, who amidst the whirling and screaming of innumerable machines of vast dimensions, sat thoughtfully clipping off neat balls of cotton as they grew under her hand with marvellous rapidity. First a

point, then a little pea; then, almost too quickly for the eye to detect it, the cotton balls, wound with beautiful regularity, formed themselves, while the young woman with her scissors, never forgetting her task for a moment, severed them one after the other, knowing the exact moment when to clip the thread and let fall into a basket below the balls, which were always found to contain the same number in a pound weight. This machine was among the earliest efforts of the inventive genius of Marc Isambard Brunel. It gave at once a marvellous impulse to the employment of cotton spinning; for with the common sorts of cotton the cost of wooden reels was now unnecessary, and everybody could tell by weighing, in a moment, how much of actual cotton he had obtained for his money. Brunel's machine measured the length of the thread which is wound, and proportioned the size of the ball exactly to its weight and fineness. Unhappily for the ingenious inventor, he neglected to secure the benefit of his idea, and while fortunes were realized through its means, he himself remained without any reward. Nearly sixty years ago, when he visited the workshops of Messrs. Strutt, at Belper, in Derbyshire, where there were six hundred and forty persons employed, he wrote in his diary, "I observed they had adopted my contrivance for winding cotton into balls. There were about twenty spindles on one swing."

A lady, a friend of Brunel, having once expressed her admiration to him of the little cotton balls, then a novelty, suggested to him jokingly that he ought to devise something to save the ladies the trouble of hemming and stitching. The remark was forgotten by

the lady, until one day she was shown a new machine, not that famous sewing machine which has since delighted so many beholders, but an expressly ingenious patent for trimmings and borders for muslins, lawns, and cambrics. The inventor's account, in his specification, of its advantages was, "that the operations of hemming, whipping, or otherwise securing from ravelling the edges of trimmings cut in narrow slips out of border webs, as they have unavoidably been hitherto, were by this invention altogether saved."

"Admirable!" exclaimed the lady; "but are you the inventor of this too?"

"The inventor, but not the originator," returned her visitor, perceiving that his questioner had forgotten the conversation which had been so fruitful in his mind.

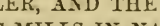
"Indeed! who then was the originator?"

"Yourself, madam," replied Brunel; and the circumstances of their previous conversation flashed upon the lady's mind in a moment.

The comparison to the elephant's trunk, which is equally capable of raising a great bulk, or of picking up a pin, was never more aptly made than in the case of Brunel. He found amusement, amidst his grander schemes, in devising a number of little inventions for obviating some trifling inconvenience in daily life. An aged friend of his finding a difficulty in shuffling cards for whist, a game in which she found recreation, Brunel invented, expressly for her use, a card shuffler; the precise form of which is now forgotten. The cards were placed in a box, the handle was turned, and in a few seconds the sides of the box opened, presenting the

pack divided into four parts, and the cards effectually mixed. This ingenious machine was presented by Brunel to Lady Spencer.

FOLEY THE FIDDLER, AND THE INTRODUCTION OF SPLITTING-MILLS IN NAIL-MAKING.



THE most extraordinary and the best attested instance of enthusiasm in conjunction with perseverance, says Coleridge, is related of the founder of the Foley family. This man, who was a fiddler, living near Stourbridge, was often witness of the immense labour and loss of time, caused by dividing the rods of iron necessary in the process of making nails. The discovery of the process called splitting-mills, was first made in Sweden, and the consequences of this advance in art were most disastrous to the manufacturers of iron about Stourbridge. Foley, the fiddler, was shortly missed from his accustomed rounds, and was not again seen for many years. He had mentally resolved to ascertain by what means the process of splitting bars of iron was accomplished; and, without communicating his intention to a single human being, he proceeded to Hull, and thence, without funds, worked his passage to the Swedish iron port. Arrived in Sweden, he begged and fiddled his way to the iron foundries, where, after a long time, he became a universal favourite with the workmen; and, from the apparent entire absence of intelligence, or anything like ultimate object, he was received into the

works, to every part of which he had access. He took the advantage thus offered, and having stored his memory with observations and all the combinations, he disappeared from amongst his kind friends as he had appeared—no one knew whence or whither. On his return to England he communicated his voyage and its results to Mr. Knight, and another person in the neighbourhood, with whom he was associated, and by whom the necessary buildings were erected, and machinery provided. When at length everything was prepared, it was found that the machinery would not act; at all events, it did not answer the sole end of its erection—it would not split the bar of iron. Foley disappeared again, and it was concluded that shame and mortification at his failure, had driven him away for ever. Not so: again, though somewhat more speedily, he found his way to the Swedish iron works, where he was received most joyfully, and, to make sure of their fiddler, he was lodged in the splitting-mill itself. Here was the very end and aim of his life obtained beyond his utmost hope. He examined the works, and very soon discovered the cause of his failure. He now made drawings, or rude tracings, and having abided an ample time to verify his observations, and to impress them clearly and vividly on his mind, he made his way to the port, and once more returned to England. This time he was completely successful, and by the results of his experience, enriched himself and greatly benefited his countrymen.

THE BEGINNING AND END OF PARACHUTES.

THERE can be no doubt that the first idea of the parachute was taken from the umbrella, or rather the parasol. Father Loubère, in his curious account of Siam, relates that a person, famous in that remote country for his dexterity, was accustomed to divert the king and the royal court by the prodigious leaps which he took, having two umbrellas with long slender handles fastened to his girdle. He generally alighted on the ground, but was sometimes carried by the force of the wind against trees and houses, and not unfrequently into the river. Not a great many years ago the umbrella was, at least on one occasion, employed in Europe with similar objects, as well as in America. In the campaign of 1793 a French general, named Bournonville, having been sent by the National Convention, with four more commissioners, to treat with the Prince of Saxe-Coburg, was, contrary to the rules of war, detained a prisoner with his companions and sent to the fortress of Olmutz, where he suffered a rigorous confinement. In this cruel situation, he made a desperate attempt to regain his liberty. Having provided himself with an umbrella he jumped from a window forty feet high, but being a very heavy man, this screen proved insufficient to let him down safely. He struck against an opposite wall, fell into the ditch, and broke his leg, and was carried in this condition back again to his dungeon.

Blanchard was the first person who ever constructed a parachute, for the purpose of using it with a balloon in cases of accident while aloft. During an excursion which he took from Lisle about the end of August, 1785, when he traversed, without halting, a distance not less than three hundred miles, he let down a parachute with a basket fastened to it containing a dog, from a great height, which fell gently through the air, and conveyed the animal to the ground unhurt. Since that period the practice and management of the parachute have been carried much farther by other aeronauts, and particularly by M. Garnerin, who repeatedly descended from the region of the clouds with that very slender machine. This ingenious Frenchman visited London during the short peace of 1802, and made two ascents with his balloon, in the second of which he let himself fall from an amazing elevation with a parachute. This consisted of thirty-two gores of white canvas formed into a hemispherical shape of twenty-three feet in diameter, and having a hole in its centre admitting short pieces of tape to fasten it to the several gores. About four feet and a half below the top a wooden hoop, of eight feet diameter, was attached by a string from each seam; so that when the balloon rose, the parachute hung like a curtain from this hoop. Below it was suspended a cylindrical basket covered with canvas, about four feet high and two and a quarter wide. In this basket the aeronaut, dressed in a close jacket and a pair of trowsers, placed himself and rose majestically from an enclosure near North Audley Street, at six o'clock in the evening of the 2nd of September. After hovering seven or eight minutes in the upper region of the atmosphere, he medi-

tated a descent in his parachute; and cut the cord by which it was attached to the net of the balloon. It instantly expanded and for some seconds it descended with an accelerating velocity, till it took such wide oscillations that the basket or car was at times thrown almost level or horizontal with the parachute. Borne along at the time by the influence of the wind the parachute passed over Marylebone and Somer's Town, and almost grazed the houses of St. Pancras. At last it fortunately struck the ground in a neighbouring field, but the shock was so violent as to throw Garnerin on his face, by which accident he received some cuts and bled considerably. He seemed to be much agitated, and trembled exceedingly at the moment he was released from the car. One of the stays of the parachute had chanced to give way, which untoward circumstance deranged the apparatus, disturbed its proper balance, and threatened the adventurer during the whole of his descent with immediate destruction. At the moment of separating the parachute the balloon took a rapid ascending motion, and was found next day twelve miles distant from the place of departure. M. Garnerin, however, was not daunted by this accident. He became bolder and bolder in his experiments, and at length ventured to ascend in the darkness of the night, a feat now common with aeronauts, but sixty years ago new to the public, and considered a proof of extraordinary daring.

The only aeronaut who ventured to construct a parachute differing in any remarkable way from the inverted umbrella form of Garnerin was Mr. Cocking, whose disastrous descent took place on the 24th of July, 1837.

Mr. Cocking appears to have imbibed his taste for this dangerous kind of experiment, from having been present at one of Garnerin's descents. Pondering on the subject one day, he observed an open umbrella accidentally let fall from the balcony of a house into the street. He noticed that the umbrella fell for the first few feet with the handle downwards, but that after several oscillations its position was reversed, and having become inverted it fell steadily to the ground. From this he unhappily inferred that the proper shape of such a construction was exactly the opposite to that used by Garnerin, that it should have a convex instead of a concave surface, or a cone with its apex downward. Having completed a machine of this kind, his great difficulty was to find a means of conveying it to a sufficient altitude to make a satisfactory descent, which he decided to be about a mile and a quarter. This, however, was at last furnished by the construction by the proprietors of Vauxhall Gardens of a balloon of extraordinary dimensions; and Mr. Green, who undertook to ascend with the balloon, was unfortunately induced to consent to permit Mr. Cocking to attach his singular-looking construction to the car by a rope of forty or fifty feet long.

On the day fixed for the ascent, a vast concourse of people assembled at the gardens, attracted by the singular appearance of the new parachute. At twenty-five minutes to eight in the evening, the huge balloon ascended with its unaccustomed appendage — Mr. Cocking sitting in the car attached to the parachute. The position of Mr. Green and his companion, Mr. Spencer, was scarcely less dangerous than that of their

sanguine companion, who from time to time held converse with them, as the parachute swang with him in mid-air. Hitherto, in the case of parachute descents, the custom had been to construct a balloon of cheap materials, merely to serve for one ascent, and which was generally either lost or destroyed; for no aeronaut could be found who would undertake to ascend, and suffer so great a weight to be instantaneously separated from the balloon. Mr. Cocking's construction was, moreover, unusually heavy, weighing, with its inventor in the car, 393 pounds. From the difficulty of rising with so great an incumbrance, it was found necessary either to make the descent or finally abandon it, when the aeronauts had attained a height a little under a mile, the party being then over Blackheath. To the invitation of his companions to relinquish the scheme, and to mount to the balloon car by means of tackle provided for the purpose, the enthusiastic inventor only returned a good-humoured refusal, and, with a "Good night," and a warning to his associates above him, he finally severed himself from the rope. Then began, for the travellers in the car above, one of the most perilous voyages ever experienced in balloon travelling.

"I desired Mr. Spencer," says Mr. Green, in his exciting narrative of the events of that evening, "to take fast hold of the ropes, and, like myself, to crouch down in the car. In consequence of being compelled to keep hold of the valve-line, of course I had but one hand which was available for the purposes of safety. With that hand, fortunately, in the perilous situation into which we were speedily thrown, I was able to maintain my position.

"Scarcely were these words uttered before we felt a slight jerk upon the liberating iron, but quickly discovered, from not having changed our elevation, that Mr. Cocking had failed in his attempt to free himself. Another, but more powerful jerk ensued, and in an instant the balloon shot upwards with the velocity of a skyrocket.

"The effect upon us at this moment is almost beyond description. The immense machine which suspended us between 'heaven and earth,' whilst it appeared to be forced upwards with terrific violence and rapidity through unknown and untravelled regions, amidst the howlings of a fearful hurricane, rolled about as though revelling in a freedom for which it had long struggled, but of which, until that moment, it had been kept in absolute ignorance. It at length, as if somewhat fatigued by its exertions, gradually assumed the motions of a snake working its way with astonishing speed towards a given object. During this frightful operation the gas was rushing in torrents from the upper and lower valves, but more particularly from the latter, as the density of the atmosphere through which we were forcing our progress pressed so heavily on the valve at the top of the balloon, as to admit of comparatively but a small escape by that aperture.

"At this juncture, had it not been for the application to our mouths of two pipes leading into an air-bag, with which we had furnished ourselves previous to starting, we must within a minute have been suffocated, and so, but by different means, have shared the melancholy fate of our friend.

"This bag was formed of silk, sufficiently capacious

to contain 100 gallons of atmospheric air. Prior to our ascent the bag was inflated, with the assistance of a pair of bellows, with fifty gallons of air, so allowing for any expansion which might be produced in the upper regions. Into one end of this bag were introduced two flexible tubes, and the moment we felt ourselves to be going up in the manner just described, Mr. Spencer, as well as myself, placed either of them in our mouths. By this simple contrivance we preserved ourselves from instantaneous suffocation—a result which must have ensued from the apparently endless volume of gas with which the car was enveloped. The gas, notwithstanding all our precautions, from the violence of its operation on the human frame, almost immediately deprived us of sight, and we were both, as far as our visionary powers were concerned, in a state of total darkness for between four and five minutes.

"As soon as we had partially regained the use of our eyes, and had somewhat recovered from the effects of the awful scene into which, from the circumstances, we had plunged, our first attention was directed to the barometer. I soon discovered that my powers had not sufficiently returned to enable me to see the mercury; but Mr. Spencer found that it stood at 13·20, giving an elevation of 23,384 feet, or about four miles and a quarter.

"I do not conceive, from the length of time I had been liberating the gas, that this was anything like our greatest altitude, for we were evidently effecting a rapid descent. This impression is corroborated by a rough calculation, which leads me to believe, knowing the customary rate at which the gas makes its escape, taken in

consideration in conjunction with the length of time I had been pulling the valve-line, that we had lost at least 30,000 feet of gas, or 180,000 gallons—a total of 5000 feet more than my own balloon will contain.

"We were now rapidly on the descent, having got rid of all the unusual annoyances to which I have referred; and finding that we were proceeding downwards with the ordinary calmness and steadiness, although with much speed, we hastened to empty two tin vessels of water which we had taken up for the purpose, and to charge them with the atmospheric air through which we were then descending. Our desire was to effect this object at our greatest altitude; but, from the circumstances which I have detailed, we were unable to accomplish that end, and when the vessels were filled, the mercury in the barometer had ascended to 17·50, or an elevation of 16,632 feet—about three miles.

"When we had accomplished this matter, finding ourselves suffering severely from cold, we referred to the thermometer, which stood at 28', four degrees below the freezing point.

"We were at this period apparently about two miles and a half above a dense mountain of clouds, which presented the appearance of impenetrable masses of dark marble, whilst all around us was shed the brilliant rays of the setting sun. We continued to descend with great rapidity, and as we approached the clouds that velocity considerably increased. At this time, so large had been our loss of gas, that the balloon, instead of presenting to our sight its customary rotund and widely-expanded form, now merely looked like a comparatively small parachute, or half dome, without any aperture in its

centre. We had parted with at least one-third of our gas, and were as far beneath the balloon itself as fifty or sixty feet."

It was not until the following day that the balloon travellers learned the fate of their unfortunate companion. The construction in which he had placed so much confidence unhappily proved altogether unadapted for sustaining itself in the air. It collapsed, and turned over when at a vast height, and, rapidly descending, dashed the unfortunate occupant of its car with terrible violence upon the ground, near Lee, in Kent, where his lifeless body was picked up by some farm labourers. Parachutes have ended where they began, in the umbrella form used by Garnerin. Since Mr. Cocking's death, numerous successful descents have been made by means of constructions of this kind; but, on the whole, the parachute does not appear to be adapted to attain any really useful purpose.

DR. CARTWRIGHT, THE INVENTOR OF THE POWER-LOOM.

One of the most ingenious, but also one of the most eccentric, of our inventors, was Dr. Edmund Cartwright, to whom the world is indebted for the power-loom. He was a younger son of John Cartwright, of Marnham in Nottinghamshire, the representative of an ancient and respectable family established at that place. Edmund was educated at Oxford, where he distinguished himself at the age of nineteen, by the publication of a

volume of poems which became popular. Destined for the Church, he obtained the appointment of curate of a country parish, and it is stated that while here he studied medicine, in order to give gratuitous advice to the poor in his neighbourhood. Attending a boy one day who was ill of a putrid fever, he happened to remember a case in which putrefaction was, as he believed, arrested by the administration of brewer's yeast. He accordingly ventured to administer yeast in small doses, and diluted with water, to his patient, who speedily recovered. The fact becoming known, yeast quickly became a fashionable remedy, though now almost forgotten. Having been appointed in 1779 to the living of Goadby Marwood, he began a number of experiments in farming, which, though not always very successful, attracted much attention. Dr. Cartwright had no knowledge of mechanics, and reached his forty-second year before he thought of turning his attention in any way to that subject. How he came first to think of the possibility of constructing his power-loom, he has himself narrated in a curious letter to a friend:—

"Happening," he says, "to be at Matlock in the summer of 1784, I fell in company with some gentlemen of Manchester, when the conversation turned on Arkwright's spinning machinery. One of the company observed that as soon as Arkwright's patent expired, so many mills would be erected, and so much cotton spun, that hands never could be found to weave it. To this observation I replied that Arkwright must then set his wits to work to invent a weaving mill. This brought on a conversation on the subject, in which the Manchester gentlemen unanimously agreed that the thing

was impracticable; and, in defence of their opinion, they adduced arguments which I certainly was incompetent to answer, or even to comprehend, being totally ignorant of the subject, having never at that time seen a person weave. I controverted, however, the impracticability of the thing by remarking, that there had lately been exhibited in London an automaton figure which played at chess. Now you will not assert, gentlemen, said I, that it is more difficult to construct a machine that will weave, than one which shall make all the variety of moves which are required in that complicated game. Some little time afterwards, a particular circumstance recalling this conversation to my mind, it struck me that, as in plain weaving, according to the conception I then had of the business, there could only be three movements, which were to follow each other in succession, there would be little difficulty in producing and repeating them. Full of these ideas, I immediately employed a carpenter and smith to carry them into effect. As soon as the machine was finished, I got a weaver to put in the warp, which was of such materials as sail-cloth is usually made of. To my great delight a piece of cloth, such as it was, was the produce. As I had never before turned my thoughts to anything mechanical, either in theory or practice, nor had ever seen a loom at work, or knew anything of its construction, you will readily suppose that my first loom was a most rude piece of machinery. The warp was placed perpendicularly, the reed fell with the weight of at least half a hundredweight, and the springs which threw the shuttle were strong enough to have thrown a congreve rocket. In short, it required the strength of two

powerful men to work the machine at a slow rate, and only for a short time. Conceiving, in my great simplicity, that I had accomplished all that was required, I then secured what I thought a valuable property by a patent, 4th of April, 1785. This being done, I condescended to see how other people wove; and you will guess my astonishment, when I compared their easy modes of operation with mine. Availing myself, however, of what I then saw, I made a loom in its general principles nearly as they now are made. But it was not till the year 1787 that I completed my invention, when I took out my last weaving patent, August 1st of that year."

To invent new machines became now the passion of his life. In 1787, he established at Doncaster a weaving and spinning factory, containing ten looms which wove muslin, eight that wove cotton cloth, one that wove sail-cloth, and one that wove cotton checks. To move all this complicated machinery the Doctor employed, for a long time, the labour of an ox; but two years later he substituted a steam-engine for the purpose. His career, however, was far from prosperous. The old troubles of inventors, the hostility of the operatives, who thought that the introduction of the power-loom would destroy their livelihood, and the equally vexatious and unjustifiable efforts of rival manufacturers to deprive him of his rights, involving him in expensive law-suits, while they enticed from his service his best workmen, rendered the weaving factory at Doncaster an unprofitable speculation, and it was finally abandoned in 1793. Before this, he had patented two devices for combing wool by machinery instead of by hand, which

still continue in use in an improved form, besides machines for breaking and crushing hemp and flax, washing wool, preparing and spinning fibrous materials, cutting the pile of velvets and similar fabrics, and a machine for making rope, which he termed a "cordelier." His ardour for inventing in his new field of mechanics continued unabated. Though ruined in fortune by his previous labours, he still continued to devise and construct new machines for saving labour.

"In 1795," says Mr. Bennet Woodcroft, "he obtained a patent for a form of brick, with which he could build an arch that would have no lateral thrust, and would rest like a beam on two perpendicular walls or pillars. When he removed to London, in 1796, he constructed a room in his house in the New Road with these patent or geometrical bricks, which were formed with a rebate on their opposite sides, and keyed the courses, so that no bond-timber was required in the walls. Wyatt, the architect to George III., had a share in this project; but, from the great cost of the bricks, it came to nothing. In 1797 he had another patent for constructing floors, partitions, ceilings, and roofs with tiles. This was an improvement on a similar method described by L'Espie many years before, and which, we believe, Alderman Beckford adopted in his town mansion, to diminish the risk of fires. About this time Mr. Cartwright became acquainted with Fulton, the American engineer, and made a model of a boat impelled by paddle-wheels that were moved by clockwork. Lord John Russell, now Earl Russell, when a boy of about ten years of age, used, for his amusement, to set it afloat on the stew-ponds in the gardens at Woburn."

Cartwright also invented, about the end of the last century, some improvements in the steam-engine, and was shortly afterwards engaged by the Duke of Bedford to superintend his model farm at Woburn, where he continued till 1807. In 1808 he presented a petition to Parliament for remuneration for his invention of the power-loom, stating that he had spent upwards of £30,000 in bringing it to perfection; and in the following year he was fortunate enough to obtain a grant of £10,000, which was stated to be for "the great service he had rendered to the public by his invention of weaving." Thus relieved from the pressure of worldly cares, Dr. Cartwright purchased a small farm at Hollenden, near Sevenoaks, in Kent, where he spent the remainder of his life, equally divided between his favourite pursuits of agriculture and mechanics. One of his singular contrivances was a steam-engine to work with alcohol, instead of water, which was provided with a means of regularly condensing the steam, and returning the somewhat costly fluid into the boiler—a system which the temperance societies of the present day would probably have objected to, as presenting more temptations to engine-drivers than is consistent with the safety of passengers. Mr. Woodcroft gives an interesting account of the fruits of his active genius in this retirement. Many of his inventions were never patented by him, among which one was for the application of the tread-wheel to the working of trains, an apparatus for beating and kneading dough which he made for his own household, a reaping machine, a three-farrow plough, a dibbling machine for planting wheat, and a carriage to be moved by the labour of the person

seated in it. By means of this latter contrivance two men, in 1819, travelled in a cart, weighing with its load sixteen hundredweight, twenty-seven miles in one day, the journey including two long and steep hills. This cart was practically employed by the Doctor, to the great astonishment of the country folks of the neighbourhood, in conveying necessaries from the market town to his farm. Besides these he suggested a method for preventing the forgery of bank-notes, by sending to India a paper-maker, who, combining his own knowledge of the art with the Oriental practice, might produce a paper which it would be impossible to imitate. He also made many experiments on the effect of sugar in fattening sheep quickly, and showed that it would be a profitable practice if sugar could be had for fourpence a pound, which it may be remarked is considerably above the price of coarse sugar when free from duty. He discovered that a solution of common salt would arrest and prevent mildew in wheat, and when at Woburn he made numerous experiments on the effect of manures, the results of which he communicated to the public in an essay on the subject. The poet Crabbe, who was personally acquainted with this ingenious man, says:— "Few persons could tell a good story so well, no man make more of a trite one. I can remember him, the portly dignified old gentleman of the last generation, grave and polite, but full of humour and spirit." He died in 1823 at Hastings, in his eightieth year, and was buried at the parish church of Battle, where a monument is erected to his family.

Dr. Cartwright belonged to a family, who appear to have been distinguished by their ingenuity and active

benevolence. His father, Mr. John Cartwright, of Marnham, was a man of great energy. He was remembered as among those who chiefly aided in putting an end to the system of giving "vails," as the exorbitant gifts of money to servants were then called, a system which had become so burdensome as to render it impossible for any but the rich to visit at the houses of distinguished persons. Dr. Cartwright's elder brother was long celebrated as the advocate of parliamentary reform. Hazlitt gives an interesting sketch of him as the "man of one idea" in his "Essays." Another brother, Charles Cartwright, was an officer in the navy, of whom it is related that he refused to accept prize money amounting to upwards of one thousand pounds allotted to him after an engagement, and insisted on its being divided among the sailors who had served with him on the occasion. Dr. Cartwright's other brother, George, was a distinguished officer in the army, who acted as aide-de-camp to the Marquis of Granby; and who published in 1792, at Newark, in Nottinghamshire, a valuable work in three quarto volumes, entitled, "A Journal of Transactions and Events during a Residence of nearly Sixteen Years on the Coast of Labrador," which for the first time gave an accurate account of the life and habits of the Esquimaux tribes.

THE LAYING OF THE GREAT ATLANTIC CABLE.

It was in the latter part of the month of July, 1857, that the "Niagara" and "Agamemnon," the latter a vessel of war lent by the British Government for the purpose, sailed for Queenstown, on the coast of Ireland, having aboard each one half of the great Atlantic Cable, to be laid down between the Old and New Worlds. While the two vessels lay about a quarter of a mile apart in the Cove of Cork, their cables were passed to each other, temporarily joined, and for the first time a circuit was established through two thousand five hundred unbroken miles of submarine wires. The "Niagara's" being attached to the galvanometer, and the "Agamemnon's" brought directly to the battery, an electrical current was found to pass immediately, though at first slowly, thus at once putting at rest the anxious question of transmission through such an extraordinary length of wire. It was at first intended that the two vessels should proceed to mid-ocean, and then, having spliced the cable, should separate and steer one for Newfoundland, the other for the coast of Ireland. At the last moment this plan was changed, and it was determined that the "Niagara" should commence laying down the cable from the Irish coast westward, that she should be accompanied by all the vessels of the fleet, and that reaching mid-ocean they should join cables. An argument in favour of this arrangement was, that one end of the cable being ashore, it could not be all lost in event of an accident. It was further contended

that by this plan there would be much less weight of cable to be sustained at any one time. Then the vessels of the fleet would be together, ready to give each aid in any emergency, and the work, so it was believed, could be more satisfactorily performed by this than by the mid-ocean arrangement.

After several experimental trips, improvements in the paying-out machine in the method of coiling, and other matters upon which the managers of the enterprise had obtained dear-bought experience, the gallant vessels again set sail in June, 1858, deeply sunk in the water with their enormous freights. New misfortunes, however, awaited them. After having been three days at sea, the expedition was overtaken by a fearful gale, which continued without intermission for nine days. On the seventh day of this heavy weather, the ships, which continued to keep together, had to part company, and the "Agamemnon" was obliged to send before the wind for thirty-six hours; her coals got adrift, and a coil of her cable shifted, so that her captain for some time entertained serious apprehensions for her safety, and from the immense strain her waterways were forced open, and one of her ports was broken. Two of the sailors were severely injured, and one of the marines lost his reason from fright. Yet such was the consummate skill, good seamanship, and intrepidity of her commander, Captain Priddle, that he was enabled to bring her to the appointed rendezvous, lat. 52° 2′, long. 33° 18′. The "Niagara" rode out the storm gallantly, having only carried away her jib-boom and one wing of the figure-head, the American Eagle.

Arrived at their rendezvous the splice was made, and

the two vessels steamed away; but scarcely had they got out of sight of each other ere the cable broke, to the intense disappointment of all on board. In the great gale which the "Agamemnon" had encountered her vast unmanageable coil of cable had shifted, and become a mere shapeless, tangled mass, with which it seemed impossible to deal in any way; but this difficulty was surmounted by the indefatigable zeal of the officers and men of science aboard. Again and again, however, the cable parted, and the magno-electric current refused to pass. After hauling up, cutting, and resplicing with indomitable patience, they were compelled to return again unsuccessful. The expedition had not only ended, but three hundred miles of the valuable cable had been lost in mid-ocean during this second trial. The credit of the company fell rapidly, and the Atlantic cable was virtually consigned to the long catalogue of impracticable failures. Still the managers of the enterprise did not falter. They had provided an extra supply of wire in case of loss, and more than enough to compass the ocean yet remained. The summer was passing, and no time was to be lost; and on Saturday, the 17th July, the high-spirited men who had been so unfortunate with the previous attempts, again sailed upon their mission. Few persons in England or America had any hope of a good result; but suddenly at noon on the 5th of August the city of New York was electrified by the announcement of the arrival of the "Niagara" with the tidings that the Atlantic cable was safely laid. Men were generally incredulous; even the sanguine shook their heads in doubt. But the news was confirmed: the confirmation was immediately tele-

graphed to all parts of the United States, and the whole country broke out in uproarious rejoicings. Bells were rung, bonfires blazed, business ceased, illuminations were seen, and the press everywhere discussed the news so important to the American people. Finally, on the 16th of August, the tidings reached New York from Newfoundland that the Queen's message, which it had been arranged should be the first through the wires, had been received. It was as follows :—

"To the President of the United States, Washington.

"The Queen desires to congratulate the President upon the successful completion of this great international work, in which the Queen has taken the deepest interest.

"The Queen is convinced that the President will join with her in fervently hoping that the Electric Cable which now connects Great Britain with the United States, will prove an additional link between the nations whose friendship is founded upon their common interest and reciprocal esteem.

"The Queen has much pleasure in thus communicating with the President, and renewing to him her wishes for the prosperity of the United States."

To this the President returned the following reply, also transmitted through the wires :—

"Washington City, Aug. 16, 1858.

"To Her Majesty Victoria, Queen of Great Britain.

"The President cordially reciprocates the congratulations of Her Majesty the Queen, on the success of the

great international enterprise accomplished by the science, skill, and indomitable energy of the two countries. It is a triumph more glorious, because far more useful to mankind, than was ever won by conqueror on the field of battle.

"May the Atlantic Telegraph, under the blessing of Heaven, prove to be a bond of perpetual peace and friendship between the kindred nations, and an instrument destined by Divine Providence to diffuse religion, civilization, liberty, and law throughout the world. In this view will not all nations of Christendom spontaneously unite in the declaration that it shall be held sacred in passing to their places of destination, even in the midst of hostilities?

"JAMES BUCHANAN."

Thus, though unhappily only for the brief space of twenty-three days, the two continents were placed in instantaneous communication with each other; but it was already known that the insulation was defective, owing, it is said, from the cable being coiled during its manufacture in large vats and exposed to the heat of a summer's sun, intensified by the tarred coating of the cable, by which the gutta percha was melted and worn bare in various places. Before the communication ceased entirely one hundred and twenty-nine messages had been sent from Valentia, in Ireland, to Newfoundland; while the number sent from Newfoundland to Valentia was two hundred and seventy-one, making a total of four hundred messages sent across the Atlantic. Among these messages was one from the Horse Guards, London, countermanding the return of the sixty-second

regiment, which, by avoiding the shipment and transportation of troops, saved fifty thousand pounds to the British Government.

THE END OF LAVOISIER.

The great French chemist, Lavoisier, did not escape from the terrors of the French revolution—that social and political tempest in which the most illustrious were the first to suffer. Cast into prison upon the most absurd and groundless charges, the Lycée des Arts sent a deputation of their number to him to assure him of the interest taken by that learned body in the preservation of a life so valuable to mankind; and to place upon his head a crown in token of the respect entertained towards the man who had rendered so many services to his country. Unfortunately, Lavoisier, besides being a man of eminent merit and of high connections, was a farmer of taxes, a class towards which the public enmity raged with extraordinary fury. Perceiving that his life was in danger, he sought refuge in a place prepared for him by M. Lucas, who had once been the doorkeeper at the Académie des Sciences; but hearing that twenty-eight of his associates had been consigned to the revolutionary dungeons, his generous nature was unwilling to prolong the danger to which he exposed his benefactors, and he voluntarily surrendered himself to the jailers.

In his prison Lavoisier continued those scientific

labours which had gained him so great a fame, although he was informed that he would be brought to trial in a few days. To be tried at that time was to be condemned. Lavoisier begged only a short delay in order that he might complete a few experiments and bequeath their results to the world; but the reply of the execrable Fouquier Tinville, the public prosecutor, was simply, "The republic has no need of chemists, nor of chemistry; the course of justice shall not be interrupted."

A few days later this great man perished by the guillotine. Lavoisier was a man of great generosity and benevolence. Only the year before the commencement of the revolution the town of Blois being threatened by a famine, he had placed a sum of fifty thousand francs at the disposal of the town without fixing any time for repayment. He was remarkable for his kindness to youthful genius, and took delight in assembling young students in his laboratory, many of whom subsequently became scarcely less famous than himself.

SIR CHARLES BELL, THE PHYSIOLOGIST.

Sir Charles Bell, whose discovery of the true functions of the nervous system is universally regarded as the most important contribution to physiological science since the demonstration of the circulation of the blood by Harvey, was a man of a remarkably humane and

kindly disposition. One day a young French medical student having been introduced to Sir Astley Cooper, to be present at an operation performed by the latter, the young man displayed an amount of nervousness hardly consistent with the surgical profession. Perceiving that Sir Astley observed his agitation, he apologized, lamenting that his nervous system would probably compel him to give up a study to which he was, nevertheless, ardently attached. "No, no," said Sir Astley, "you will recover from all that. Come; I will introduce you to Charles Bell, who will tell you how his courage failed him on his first attempt to bleed a patient." "Charles Bell," says M. Pichot, the relater of this anecdote, "received me with the same kindness; and, the story of the bleeding being mentioned to the great operator, he replied, 'Sir Astley has only spoken of my *first* experiment, but I will confess that if I had to repeat it to-morrow it would cost me almost as great an effort,' and he admitted that whenever he performed an operation, he had to contend with the same agitation."

Bell's great discovery was that the nerves of motion and the nerves of sensibility are common to all animals, but that the third, or superadded, division of nerves exists only where the organization requires more elevated functions. It was he alone who showed the method by which the brain communicates its will or impressions to the body, as well as how it receives impressions of pain or pleasure. His system was at first received with little favour, at least in this country. The most eminent in his profession ridiculed his suggestion that there were respiratory organs in the face, and that these were connected with expression. When Aber-

nethy had studied and acknowledged the truth of his system, he generously exclaimed, "What blockheads we have all been for not having thought of this grand and simple truth before!" In the dedication to his work on the nervous system, published in 1830, Bell says, "Whatever may be thought of the arguments adopted in this volume, the facts admit of no contradiction; and it may hereafter be a question of curiosity to know how they were received at first. The pleasure I enjoyed in my researches was great; the reception given to them by science has been contrary to what I expected. The first announcement of my work obtained not a single word of encouragement from the faculty. Some time later, when the publication of my papers by the Royal Society rendered it impossible to pass them by without notice, the interest they excited turned to the advantage of those who contradicted my discoveries, or pretended to have forestalled them;" and he adds, almost pathetically, "For myself this signifies little, but I confess my regret that the young students who have so favourably and zealously assisted me in these researches should have been deceived in their hope of giving satisfaction to their profession."

Continental surgeons, however, treated him with more generosity. It was in France that Bell received one of the noblest testimonies of homage, perhaps, ever rendered to scientific greatness. Being in Paris, he was desirous of hearing a surgical lecture of M. Roux, the eminent son-in-law of the surgeon Baron Boyer. Accordingly he attended the lecture-room of the Hôtel Dieu, the great Paris Hospital. Taking his seat among the young men, as he believed unobserved, Bell

prepared to listen, but the Professor, who had enjoyed the hospitality of Bell in England, recognized his great contemporary, and having announced the fact to his audience, he dismissed them without a lecture, saying, with the energetic gesticulation peculiar to Frenchmen, "Gentlemen, enough for to-day. You have seen Charles Bell."

Bell was the son of a poor Scottish clergyman—a minister of the Episcopal Church, who performed the duties of a small curacy in Monteith with an annual stipend of twenty-five pounds, on which scanty pittance he brought up his three first sons. Charles Bell, like many other eminent men, was fortunate in possessing an excellent mother. On the margin of a sketch of his career, published in a medical journal, a copy of which was found among his papers, he had written in pencil the following note, referring to a statement as to his early education: "Nonsense! I received no education but from my mother; neither reading, writing, ciphering, nor anything else. My education was the example set me by my brothers; there was in all the members of my family a reliance on self, and by imitation I obtained it. People prate about education, and put out of sight example, which is all in all."

Bell never attained the lucrative practice enjoyed by other eminent surgeons in London, and such good fortune as that of Sir Astley Cooper, who is stated to have earned in one year (1815) the enormous sum of twenty-one thousand pounds sterling, was beyond his dreams. His mind was almost incessantly occupied with anatomy, in which he found endless delight. He regarded his favourite study as something far greater than a mere

classification of the different parts of a body. In his journal for March, 1818, was found the note :—"I have solicited an interview with Rennie, the engineer, to discourse with him on the uses of anatomy, and to show him how the all-powerful Creator made arches, bridges, cables, and all that engineers undertake."

His most popular work is his "Treatise on the Human Hand." He died somewhat suddenly, of disease of the heart, at the seat of his friend, Mr. Holland, near Worcester, in 1842.

A PHILOSOPHER'S CHANGE OF NAME.

It is a curious circumstance that Cuvier, though always known by the Christian name of George, was not so baptized. George was the name of an elder brother who died shortly before the birth of the great scientific discoverer, who was a second son. Full of grief for the loss of her firstborn, Madame Cuvier had little hope of seeing even the new-comer arrive at manhood; for his feeble and sickly constitution demanded her incessant care. In after life the world-renowned naturalist cherished every circumstance connected with her memory; he delighted to recall her patient care and kindness, and to dwell upon things however trifling which reminded him of her. He liked to have about him the flowers which were her favourites, and whoever in his family circle was so thoughtful as to place a

bunch of red stocks in his study was sure to be rewarded with affectionate thanks. He had, indeed, many other reasons to remember her than his gratitude to a parent whose tenderness had snatched him from the perils of a sickly childhood; for it was she who had formed his mind, and trained him in those habits of thought and method which were so conspicuous in him in later years. He had been christened with the name of Leopold, but it appeared that in tender remembrance of her firstborn his mother would frequently call him George. The custom became confirmed with her: and when she died, Cuvier, out of respect for her memory, retained the name. Finally, after his marriage, it appearing that some difficulties might arise from his using a name that did not properly belong to him, he took the necessary steps for obtaining a legal right to it. Thus it was that Cuvier acquired the name of George.

A TERRIBLE INVENTOR.

In the year 1802 Lord Stanhope, the ingenious mechanician, called the attention of the House of Peers to some alarming rumours respecting the inventions of an American in France, with which country we were then at war. French writers had announced that ere long their ancient enemy would be astonished to see a flotilla of diving-boats which on a given signal would, to avoid

the pursuit of an enemy, plunge under water and rise again several leagues from the place where they descended. This, however, was not the most formidable item in the information which Lord Stanhope had obtained. This terrible American was stated to have invented, in conjunction with his diving-boats, an infernal machine which was to be silently and secretly carried under water, by means of one of these plungers, and attached with ease to the keels of the large men-of-war of the blockading squadron, who would find it impossible to be aware of the approach of their stealthy invader until a sudden and terrific explosion blew them in numberless fragments into the air. The inventor of these hitherto unheard-of modes of warfare was Robert Fulton, a native of the United States, who had lived in England sometime, had been employed by the Duke of Bridgewater, and had been intimate with Watt, and other ingenious Englishmen. Finally, in 1803, an association of gentlemen was formed for the purpose of procuring information as to the progress of Fulton's designs, and as to what might be their consequences; and the result of the report of this association was so alarming, that Mr. Addington (afterwards Lord Sidmouth), then prime minister, opened a communication with Fulton, the object of which was to deprive France of the benefit of his inventions and services, and give England the advantage of them by inducing him to withdraw from France. Fulton, who was afterwards celebrated as the founder of the system of steam navigation in the United States, had commenced his experiments, with the authority of the Government of Napoleon, —then First Consul—at Brest, in the year 1801, and his

report to the French executive furnishes a curious account of his experiments :—

On July 3, in that year, he embarked with three companions on board his plunging boat in the harbour of Brest, and descended in it to the depth of twenty-five feet; but he did not attempt to go lower, because he found that his imperfect machine would not bear the pressure of a greater depth. He remained below the surface one hour: during which time they were in utter darkness. Afterwards, Fulton descended with candles, but finding a great disadvantage from their consumption of vital air, he caused previously to his next experiment, a small window of thick glass to be made near the bow of his boat, and he again descended on July 24, 1801. He found that he received from his window, or rather aperture covered with glass, for it was no more than an inch and a half in diameter, sufficient light to enable him to count the minutes on his watch. Having satisfied himself that he could have sufficient light when under water, that he could do without a supply of fresh air for a considerable time, and that he could descend any depth, and rise to the surface with facility; his next object was to try his boat's movements, as well on the surface as beneath it. On July 26, he weighed his anchor and hoisted his sails: his boat had one mast, a mainsail, and jib. There was only a light breeze, and therefore she did not move on the surface at more than the rate of two miles an hour; but it was found that she would tack and steer, and sail on a wind or before it, as well as any common sailing-boat. He then struck her mast and sails, to do which, and perfectly to prepare the boat for plunging, required about two minutes.

Having plunged to a certain depth, he placed two men at the engine, which was intended to give the vessel progressive motion, and one at the helm, while he, with a barometer before him, governed the machine, which kept her balanced between the upper and lower waters. He found that with the exertion of one hand only, he could keep at any depth he pleased. The propelling engine was then put in motion, and he found upon coming to the surface, that he had, in about seven minutes, made a progress of about five hundred yards. He then again plunged, turned his boat round while under water, and returned to near the place from which he began to move from. He repeated his experiments several days successively, until he became familiar with the operation of the machinery, and the movements of the boat; and he found that it was as obedient to her helm under water, as any boat could be on the surface; and that the magnetic needle traversed as well in the one situation as the other. On August 7, Fulton again descended with a store of atmospheric air compressed into a copper globe of a cubic foot capacity, into which two hundred atmospheres were forced. Thus prepared, he descended with three companions to the depth of about five feet. At the expiration of an hour and forty minutes, he began to take small supplies of pure air from his reservoir, and did so, as he found occasion, for four hours and twenty minutes; he then came to the surface, without having experienced any inconvenience from having been so long under water. Fulton was highly satisfied with the success of these experiments; it determined him to attempt to try the effects of these inventions on the English ships, which were then

blockading the coast of France, and were daily near the harbour of Brest.

Satisfied with the performance of his boat, which he called the "Nautilus," his next object was to make experiments with his torpedoes. A small shallop was accordingly anchored in the roads. Fulton approached to within two hundred yards of the anchored vessel, struck her with the torpedo, and blew her to atoms, a column of water and fragments being blown nearly a hundred feet into the air. This experiment was tried in the presence of Admiral Villaret and a multitude of spectators. Fulton now projected a larger boat upon an improved plan, and capacious enough to contain eight men, and with sufficient provisions for twenty days. This boat was intended to be of sufficient strength to enable him to plunge one hundred feet under water, and contained a reservoir stated to be sufficient to enable eight men to remain in that position for eight hours. When above water the boat had two sails and looked like an ordinary vessel; but when it was to dive the mast and sails were struck.

Throughout the summer of 1801, and till the project was relinquished on account of the season, Fulton appears to have been watching the English ships which were on the coast, little suspecting the singular kind of enemy prepared to take advantage of their movements. Fortunately for the English, or perhaps, for the sanguine inventor, though some of the British men-of-war daily approached the harbour, yet none came so near or anchored in such a situation as to be exposed to the effects of Fulton's preparation. In one instance however, he came very near a British seventy-four gun

ship, which is stated to have made just in time such a change of position as to save herself. The French authorities appear soon after this to have become weary of the subject, and to have ceased to encourage Fulton; and it was ultimately against their own vessels that these machines were first tried. Tempted, it is said, by a reward secretly offered by the British Government, and probably irritated by the neglect of the French, he repaired to England, and on October 1, 1805, made an attack on the fleet of flat-bottomed boats assembled at Boulogne. He does not, however, appear to have used his diving-boat on this occasion, but only his torpedoes, which were thrown across the French vessels; but owing, as Fulton said, to a mistake in the throwing, they exploded alongside of the French vessels without doing them much injury. A few days later Fulton, in the presence of Mr. Gott and his colleague, blew up a strong-built Danish brig of the burden of two hundred tons, which had been anchored for the experiment in Walmer roads; but his inventions do not appear to have been put to any further trial.

FULTON AND THE EMPEROR NAPOLEON.

One of the most curious circumstances brought to light in connection with Fulton's experiments in France is the fact that in 1804, he actually offered to the Emperor Napoleon to construct a steam-vessel, for the purpose

of conveying the Boulogne flotilla to England. At first the Emperor appears to have looked favourably on the project, as appears from the following letter:—

"I have just read the project of citizen Fulton, an engineer, which you sent me much too late, for it seems capable of changing the face of the world. At all events I desire that you will immediately place the examination of it in the hands of a committee, composed of members of the Institute, for it is to them that the scientific men of Europe will naturally look for a decision on the question. A great physical truth stands revealed before my eyes. It will be for these gentlemen to see it, and endeavour to avail themselves of it. As soon as the report is made it will be sent to you, and you will forward it to me. Let the decision be given in a week if possible, for I am impatient to hear it. NAPOLEON.

"21*st July*, 1804."

Napoleon, however, who was notoriously subject to sudden changes of determination in such matters, seems to have soon afterwards conceived a disgust for Fulton, probably on account of his recent failures. The scheme which might have had such momentous consequences was abandoned. The Emperor refused to permit the Academy of Sciences to investigate the subject; and when M. Louis Costaz, President of the Tribunal, spoke to him on behalf of Fulton, he interrupted him angrily with the words, "There are in all the capitals of Europe a crowd of adventurers and projectors who run about offering to every government their pretended discoveries, which exist only in their imagination. They

are so many charlatans and impostors, who have no other view than to extort money. This American is one of the number. Speak to me no more about him." Yet this American only a few years later was the originator of a great and successful system of steam navigation in the United States, which preceded by some years the establishment of practical steam-vessels carrying passengers in any part of Europe.

PANORAMAS.

The invention of panoramas, by which so real a character is given to representations of cities and landscapes, is due to Robert Barker, a portrait painter in Edinburgh, who obtained a patent for his invention in 1787. Five years afterwards he exhibited one in London, representing that city itself. The American Fulton, who was more remarkable for his energy in carrying out the ideas of others than for originality of invention, introduced this new mode of painting into France about the year 1799, and was by the French generally supposed to be the inventor. In 1821, however, all previous attempts at panoramic drawing were thrown into the shade by the labours of Mr. Thomas Hornor, in making the sketches necessary for his great panorama of London. Mr. Hornor had been for some time engaged in executing drawings of landed estates in panoramic views. In the course of these pursuits he designed, and himself

constructed, an apparatus by which the most distant scenery could be delineated with great accuracy. London and its environs furnished a good subject for a more extensive application of this ingenious instrument. Accordingly, when the cross of St. Paul's was taken down in 1821 to be repaired and regilt, Mr. Hornor availed himself of the circumstance to obtain permission to erect an observatory, supported by a slight platform several feet above the highest part of the present cross; and in this lonely and perilous position he fixed his apparatus, and, after many months, succeeded in producing on a large scale a series of drawings of the surrounding view, including even minute objects at a distance of many miles. The laborious toil which this enterprising young artist had to undergo in ascending the infinite staircases and ladders to reach his solitary habitation, independently of the danger of a journey so often repeated, did not damp his ardour. All possible precautions were taken for the prevention of accidents in his exposed situation; but the wooden box in which he passed so many hours, with its frail supports of poles and ropes, was in continual peril. The weather during the summer of 1821 was unfortunately more than usually boisterous. Scarcely a day passed without the derangement of some part of the scaffolding or the machinery connected with it; and so strong became the sense of danger arising from these repeated casualties, that notwithstanding offers of increased remuneration it was frequently impossible to obtain the assistance of workmen; a fact scarcely surprising when we learn that during the high winds no one could stand on the platform without clinging for support to the framework;

while the creaking and whistling of the timbers resembled those of a ship labouring in a storm, and the situation of the young artist was not unlike that of a mariner at the masthead.

During a squall, more than usually severe, a great part of the circular framework of heavy planks, erected above the gallery for the prevention of accidents, was carried over the house-tops to a considerable distance. At this moment a similar fate had nearly befallen the observatory, which was torn from its fastenings, turned partly over the edge of the platform, and its various contents thrown into utter confusion. The fury of the wind rendered the door impassable; and, after a short interval of suspense, an outlet was obtained by forcing a passage on the opposite side. By this misfortune, independently of personal inconvenience, considerable delay and expense were occasioned ere the work could be resumed; and it became necessary to provide against similar misfortunes, by securing the observatory to a cross-beam, and constructing a rope fence.

At other times the experiences of the artist were of a more agreeable character. "On entering the cathedral at three in the morning," says Mr. Hornor, in his interesting account of his impressions during his labour, "the stillness which prevailed in the streets of this populous city, contrasted with their mid-day bustle, was only surpassed by the more solemn and sepulchral stillness of the cathedral itself. But not less impressive was the development, at that early hour, of the immense scene from its lofty summit, whence was frequently beheld 'the Forest of London,' without any indication of animated existence. It was interesting to mark the

gradual symptoms of returning life, until the rising sun vivified the whole into activity, bustle, and business. On one occasion the night was passed in the observatory, for the purpose of meeting the first glimpse of day; but the cold was so intense as to preclude any wish to repeat the experiment."

During the work portions of the scene would sometimes be in bright sunshine, and at others in obscurity, producing an incessant alteration in light and shade. Many other difficulties presented themselves; but finally Mr. Hornor surmounted them all, and succeeded in producing a complete panoramic view of the metropolis and its environs on 280 sheets of drawing paper, comprising a surface of 1680 square feet. The panorama of London, painted from these drawings, has long been familiar to London sightseers.

TELEGRAPHY UNDER DIFFICULTIES.

When the American statesman, Mr. Clay, was making a speech on the Mexican war at Lexington, in the far western state of Kentucky, in 1847, the "New York Herald" newspaper was anxious to obtain a report in advance of any other journal. For that purpose a reporter, when the speech was ready, took horse for Cincinnati, eighty miles distant, where a telegraph line had just been established. Horses had already been placed at every ten miles on the road. Over a rough,

hilly country, in the midst of wind and driving rain, the rider accomplished his journey in eight hours; but here a new difficulty was encountered. Scarcely had they begun the transmission of the speech when communication was suddenly interrupted, as if all the wires had been cut at the same moment. Not to be baffled, the man took horse again, and riding along the railway track in the dark and rainy night, he endeavoured to observe if any poles had been blown down. Nothing, however, met his notice for many miles, when the horse suddenly stumbled upon some obstacle, nearly throwing his rider. Lighting a pocket lantern which he had with him, he then discovered that the wires had been snapped asunder by the limb of a tree which had been blown down by the wind, and had fallen across them. To repair them temporarily with some wire which he had brought with him occupied but a short space, and riding back through the storm he found himself in time to transmit the remainder of the speech to New York for the newspaper of the next morning.

THE ROOF HAS FALLEN.

Lady Hawes has communicated to Mr. Beamish, the author of the Memoir of Sir M. I. Brunel, some interesting anecdotes of her father's judgment upon the strength of iron bridges and other buildings. One of these is eminently characteristic. Nearly forty years ago, when the application of cast-iron to these pur-

poses was much under discussion, Mr. Maudslay, whose great engineering talents Brunel was the first to discover, determined to exhibit his confidence in the material by erecting a cast-iron roof over his factory at Lambeth. Brunel, however, had contended that such structures would be insecure, unless well combined with ties of wrought-iron. So strongly had this opinion taken possession of his mind, that, when some one informed him in haste that a serious accident had occurred at his friend Maudslay's, he exclaimed anxiously, "The roof—the roof has fallen!" and, unhappily, this proved to be the case.

THE NATURAL PHILOSOPHER AND THE CAT.

I ONCE (says a French writer) saw a lecturer upon experimental philosophy place a cat under the glass receiver of an air-pump, for the purpose of demonstrating that life cannot be supported without air and respiration. The lecturer had already made several strokes with the piston, in order to exhaust the receiver of its air, when the cat, who began to feel herself very uncomfortable in the rarefied atmosphere, was fortunate enough to discover the source from whence her uneasiness proceeded. She placed her paw upon the hole through which the air escaped, and thus prevented any more from passing out of the receiver. All the exertions of the philosopher were now unavailing; in vain he drew the piston; the cat's paw effectually prevented

its operation. Hoping to effect his purpose, he again let air into the receiver, which, as soon as the cat perceived, she withdrew her paw from the aperture; but whenever he attempted to exhaust the receiver, she applied her paw as before. The spectators clapped their hands in admiration of the cat's sagacity, and the lecturer was compelled to remove her, and substitute another cat who possessed less penetration for the cruel experiment.

STOPPED IN TIME.

Elihu Burritt, the "learned blacksmith," tells the following exciting story of how an entire train of passengers was saved from destruction by a timely message by telegraph. "During a storm and violent gale the long railway bridge across the Connecticut, between Hartfield and Springfield, was lifted up by the wind, and thrown into the river beneath, two hundred yards in breadth, which a powerful current at the time swelled to a dreadful height by an unusual flood of rain. The line here is crossed by a bridge fifty feet above the river, after an abrupt curve has been passed. But the passengers within congratulated themselves on their comfortable situations, thinking of the blessed homes and the firesides which they soon expected to reach. On came the train, the engine blowing off its head of steam, breasting its way nobly against the gale, which almost threatened to check its progress, the hot iron hissing furiously in the falling rain. No one knew or even suspected that

the bridge was gone. For two years, by day and by night, the trains had passed and repassed, until safety had obliterated the thought of even the possibility of danger; but no bridge was there to receive them, and the long train with its precious freight rushed on towards the precipice of destruction. It was not customary to stop at this place, excepting to check the speed for the landing of passengers; but the people there had learned through the instrumentality of the telegraph, the loss of the bridge, and kept a sharp look-out for the approaching train. It came; the word was given, and they were safe. Every heart leapt from its place, and the head swam giddily with fear as the thought came of that fearful leap in the dark; and long will the passengers remember that dreadful road, and the friendly yet fearful cry of 'THE BRIDGE IS GONE!'"

A still more striking illustration of the important services frequently rendered by telegraphic communication is afforded by an instance related by Mr. Walker, the superintendent of the telegraphs of the South Eastern Railway Company. "On New Year's day, 1850," says this gentleman, "a collision had occurred to an empty train at Gravesend; and the driver having leaped from his engine, the latter started alone at full speed for London. Notice was immediately given by telegraph to London and other stations; and while the line was kept clear, an engine and other arrangements were prepared as a buttress to receive the runaway, while all connected with the station awaited in awful suspense the expected shock. The superintendent of the railway also started down the line on an engine, and on passing the runaway he reversed his engine and had it transferred

at the next crossing to the up-line, so as to be in the rear of the fugitive; he then started in chase, and on overtaking the other he ran into it at speed, and the driver of the engine took possession of the fugitive, and all danger was at an end. Twelve stations were passed in safety: it passed Woolwich at fifteen miles an hour; it was within a couple of miles of London when it was arrested. Had its approach been unknown, the mere money value of the damage it would have caused might have equalled the cost of the whole line of telegraph."

FARADAY'S FIRST PATRONS.

PROFESSOR FARADAY, in a letter written to Dr. Paris, tells the following pleasing anecdote of how he came to devote himself to the science of chemistry, in which he has since become so celebrated:—"When I was a bookseller's apprentice," he says, "I was very fond of experiment, and very averse to trade. It happened that a gentleman, a member of the Royal Institution, took me to hear some of Sir Humphrey Davy's last lectures in Albemarle Street. I took notes, and afterwards wrote them out more fairly in a quarto volume. My desire to escape from trade, which I thought vicious and selfish, and to enter the service of science, which I imagined made its pursuers amiable and liberal, induced me at last to take the bold step of writing to Sir Humphrey Davy, expressing my wishes and a hope that, if an opportunity came in his way, he would favour my views, and at the same time I sent the notes I had taken of his lectures."

Sir Humphrey was at once struck, not only with the proof which the notes of his lectures afforded of the diligence of his young and unknown correspondent, but also with the knowledge which they displayed; for it would, of course, be impossible for one ignorant of chemical science to report correctly a lecture on the subject. In a few days the bookseller's apprentice, to his great delight, received the following reply :—

"*December* 24, 1812.

"Sir,—I am far from displeased with the proof you have given me of your confidence, and which displays great zeal, power of memory, and attention. I am obliged to go out of town till the end of January. I will then see you any time you wish. It would gratify me to be of any service to you. I wish it may be in my power. I am, sir, your obedient, humble servant,

"Humphrey Davy."

Sir Humphrey kept his word. Early in 1813, Michael Faraday received a message from him, and with a joyful heart he repaired to Sir Humphrey's house in Albemarle Street. The humble appointment of assistant in the laboratory of the Royal Institution happened to be vacant, and Sir Humphrey promised to support his visitor in an application for it. The application was successful, and a few months later the young chemist went abroad with his patron and Lady Davy, acting as Sir Humphrey's amanuensis and assistant in experiments. In 1815 he returned to his duties in the laboratory of that institution which has been the scene of his great scientific labours, and where he still continues. Ultimately Mr. Faraday became Fullerian Professor,

while his investigations into the relations of heat, light, magnetism, and electricity have resulted in discourses of the utmost importance to science, and have contributed to make his name known throughout Europe.

Mr. Faraday is a man of humble origin, the son of a poor blacksmith. He was apprenticed to a bookseller, or rather to a bookbinder, or one who obtained a living by purchasing cheap sheets of books and binding them up for retail sale. This bookseller and bookbinder, whose name was Riebau, first called the attention of one of his customers, Mr. Dance of Manchester Street, to an electrical machine and some other philosophical apparatus, the work of his apprentice; and it was Mr. Dance, the "Member of the Royal Institution," referred to in Mr. Faraday's letter, who introduced the young man to that institution, where, his being fortunate enough to hear the four last lectures ever given there by Sir Humphrey, laid the foundation of his future fame.

A SUBMARINE SURVEY.

When the question was first raised of whether a telegraphic wire could be laid on the bottom of the Atlantic, every care was taken to bring together all the evidence that could be gleaned of the actual character of the vast oceanic basin which was to be the scene of the great enterprise, and to compare them with the labours of Captain Maury, who had already demonstrated the existence of a great Atlantic plain. This plain, according

to Maury, was scarcely twelve thousand feet below the level of the sea, and extended in a continuous ledge from Cape Race, in Newfoundland, to Cape Clear, in Ireland. Its greatest depth was declared to be in mid-ocean, whence it imperceptibly ascended to the shore on either side. In order to verify the theory of such a plateau, the Atlantic Telegraph Company, aided by the Governments of Great Britain and the United States, caused surveys to be made, and the knowledge thus obtained was conclusive. The plain was found to be gently levelled, so deep as to be below the reach of disturbing superficial causes and composed of particles of shells, so minutely broken up as to render their character indetectible save with the aid of a microscope. Their presence, examined by the lights of science, proved how little those profound depths had been disturbed in the course of uncounted ages, and greatly encouraged the hope that the Atlantic cable, when once laid along with them, might rest as tranquilly—perhaps as long. The tendency of these infinitesimal fragments to stick to any metallic centre exposed to them, held out the expectation that the submerged cable would soon be thickly enveloped by them, and a fresh element of security so obtained.

This submarine plateau is really a gently-levelled plain, lying just so deep as to be inaccessible to the anchors of ships, and to other sources of surface interference, and yet not so far depressed but that it can be reached by mechanical ingenuity without any very extravagant effort. It seems indeed, that it is a portion of a great zone of table land which entirely engirdles the earth, or which, at least, stretches from the western side of America to the Asiatic coast of the Pacific.

A STORM IN A TELEGRAPH OFFICE.

One afternoon, some years ago, during a heavy fall of rain, the bells of the electric telegraph, placed in a small office at one end of the St. Germain's Atmospheric Railway, suddenly began to ring, which led the attendant to suppose that he was about to receive a message. Several letters then made their appearance, but no sense could be made of them, and he was about to make the signal "Not understood," when suddenly he heard an explosion, similar to a loud pistol-shot, and at the same time a vivid flash of light was seen to run along the conductors placed against the sides of the shed. The conductors were broken into fragments which were so hot as to scorch the wooden tables on which they fell, and their edges presented evident traces of fusion. The wires of the electro-magnets, belonging to the apparatus placed in the office, were also broken, and at the same instant the attendant experienced a violent concussion, which shook his whole frame. The little office was connected with the Paris station by wires supported on posts; yet at Paris nothing remarkable occurred, except that several of the bells were heard to ring. But at a short distance from the shed, the top of one of the posts which support the wire was split; and where the wires were bent at the corners of the angles, three sharp points of light were observed several seconds after the explosion.

At the time of the explosion, an attendant, who was holding a handle which moves a needle at a short

distance from the extremity of the railway, also sustained a violent concussion, and several workmen standing about him experienced severe shocks.

This story is told by Monsieur Arago, the great astronomer, in a letter to M. Bréguet, who was of opinion that the explosion came from the railway; for, on account of the immense quantity of metal employed in its construction and the extent of its surface, it was probable that, during a thunder-storm, it would be the seat of an intense electric tension, and that the fluid thus attracted would discharge itself on the telegraphic wires, which were near the iron rails, tubes, and needles.

THE DISCOVERER OF CALIFORNIAN GOLD.

When the Swiss Guard upon which Charles X. had relied so unwisely for the maintenance of his arbitrary government, were dispersed by the revolution of 1830, a certain Captain Sutter, who had served in that body, determined to quit the country in which he and his comrades were so unpopular, and to seek his fortune in a new capacity in the far wilds of North America. A Swiss by birth, Sutter possessed all the industry and persevering energy peculiar to his countrymen. Ready to serve as a soldier where moderately good pay and a commission were offered to him, he was equally ready to clear a space in the primeval forest, or to build himself a home in the prairie. Accordingly in 1830 he set



THE DISCOVERER OF CALIFORNIAN GOLD.

sail from Havre for New York, whence in a short time he proceeded to the far-western state of Missouri. Here having acquired a little money by agriculture, he removed at the end of six years to the still more remote territory of Oregon, and finally, in 1839, he settled in California.

This country was then but little known, with the exception of the seaboard, where vessels from all parts traded with the Indians chiefly for skins; but the Swiss captain belonged to a class who can contrive to prosper anywhere. Far beyond the limits of civilized life he determined to lead an independent existence, and to become a sort of sovereign, on a small scale, of the wild country around him. Accordingly, he built with the aid of his men a fort on the River Sacramento, a very necessary protection from hostile tribes of Indians. This fort he named after his native country, New Helvetia; and in the prairie round this spot he gradually accumulated a herd of four thousand oxen, besides fifteen hundred horses and mules, and two thousand sheep. He also became the owner of a vast acreage of land under grain crops, and of two trading vessels in the river. His fort was supplied with twelve pieces of artillery, and defended by a garrison of seventy men, and its owner was beyond all question the wealthiest and most independent man in the vast range of country between the Rocky Mountains and the Pacific Ocean.

It was in September, 1847, that Captain Sutter, being anxious to construct a saw mill to be turned by water power, near a pine forest, employed for that purpose a friend skilled in engineering named Marshall. The work progressed, and the supply of water to the

mill was so situated as to wash down a great deal of mud and gravel from the higher land, passed through by the stream. Loitering by the side of the new mill one day, while the works were in progress, Mr. Marshall was struck by some glittering particles in this sand, and taking a portion away with him in a bottle he determined to show it to his enterprising employer.

"What are those bright grains?" asked the engineer, as he held up the bottle in the sun before his friend's eyes.

The Swiss eyed them attentively for some time, and then replied, "Gold. But where did this come from?"

"From yonder," replied Marshall, taking his companion to the door, and pointing to the range of hills clothed with pine trees in the distance: "if these glittering specks are gold, as I believe they are, there is wealth in those regions beside which all your flocks and herds will be a trifle."

"It is gold beyond doubt," replied the captain; "and this is how gold is generally found; but this sand is rich beyond example. We must keep this secret, and become gold-diggers together."

The precious secret was kept for a short time, and the captain and his friend found means to gather abundant proofs of the productiveness of the region in the precious metal; but it soon became whispered abroad that gold had been discovered at the American fork of the Sacramento River; and to the astonishment of the world a gold fever arose, such as had never been known before. A few labourers became possessed of some of the precious dust, and took it for sale to San Francisco, the town at the mouth of the Sacramento.

The news spread with the rapidity of a fire amidst the withered grass of the prairies. Soldiers and sailors deserted for the "diggings;" shopkeepers closed their shops, and fled to the same attractive region; and in a few months the solitudes in which the flocks and herds of the ex-captain of the Swiss Guard had lately wandered at will were filled with a motley gathering, whose labours quickly became a subject of intense anxiety in every money market in the Old and New World.

THE VICISSITUDES OF GAS-LIGHTING.

More than one hundred and thirty years ago a writer in the "Philosophical Transactions," in a narrative of the sinking of a coal-pit, belonging to Sir James Lowther, near Whitehaven, described, with remarkable minuteness and precision, the principal properties of coal-gas. A jet of natural gas had been discovered by the workmen issuing from the coal-seams at the side of the pit. By means of a funnel, the writer tells us, that he found it easy to fill a bladder in a few seconds; and he adds, "The bladder being tied close may be carried away and kept some days, and being afterwards pressed gently through a small pipe into the flame of a candle, will take fire and burn at the end of the pipe as long as the bladder is gently pressed to feed the flame, and when taken from the candle, after it is so lighted, it will continue burning till there is no more air left in the bladder to supply the flame." These facts, it appears, were de-

monstrated before the Royal Society in May 1733, when the gas was found to give a brilliant flame after it had been confined in the bladder nearly a month. Six years later Dr. John Clayton describes, in the same journal, how he has actually manufactured this gas, or "spirit of coal," as he calls it, from pieces of coal placed in a retort, and how he had been in the habit of preserving it in bladders and diverting his friends by illuminating his room with jets of gas obtained by these means. Thus was the principle of gas-lighting fully developed; but more than eighty years later the streets of our cities were still lighted—if lighted it could be called—by the feebly glimmering oil lamps which many persons yet remember.

In 1767 the subject engaged the attention of Dr. Richard Watson (afterwards Bishop of Llandaff), who published the result of his researches. His experiments show that he had examined the products arising from the distillation of pit coal with great care. The publication of these experiments excited others to apply themselves to the subject in the coal districts of various parts of the kingdom, for the purpose of extracting the tar. In the year 1784, a Mr. Diller exhibited, in London and other large towns, what he called, "Philosophical Fireworks," which were produced by the combustion of the inflammable gases, and they were deemed great curiosities. All these experiments, however, can hardly be considered as practical. It is to Mr. Murdoch of Soho, near Birmingham, the intimate friend and fellow-worker of Watt and Boulton, that we are indebted for the first application of gas to house-lighting. It was this ingenious gentleman who first exhibited the mode

in which it might be employed, instead of lamps or candles, for all the usual purposes of artificial lighting. While staying at Redruth in Cornwall, Mr. Murdoch made gas from numerous substances. He lighted his house, and also a street lamp, and had bladders filled with gas to carry at night, with which he astonished the country folks. Finally, in 1798, he constructed an apparatus at Soho, which enabled him to exhibit his plan on a far larger scale; and the Peace of 1802 afforded him an opportunity for a great display of these brilliant lights. The illumination of the Soho works on that occasion was one of extraordinary splendour. "The whole front of that extensive range of building," says one who was present, "was ornamented with a great variety of devices, which admirably displayed many of the various forms of which gaslight is susceptible. The spectacle was as novel as it was astonishing, and Birmingham poured forth its numerous population to gaze at and admire this wonderful display of the effects of science and art."

One of the most industrious and useful of the pioneers of gas lighting was Mr. Winsor, who had the undoubted merit of first lighting a street with coal gas on a system which, defective as it was, was an immense advance upon the old oil-lamp. Winsor was one of those busy sanguine men who frequently make up for want of knowledge by their perseverance in carrying a favourite point. Although he obtained a patent in 1802 for certain improvements in gas lights, he can scarcely lay claim to the character of an inventor or discoverer. He possessed scarcely any knowledge of chemistry, and was so deficient in mechanical information that it is stated

he was unable to give proper directions for the construction of his apparatus. He is believed to have obtained his notions from a Frenchman named Le Bon, who, acting upon the ideas disseminated by Murdoch, had lighted up his house and gardens in Paris in 1801 with gas obtained from wood and coal, and had contemplated lighting up the city of Paris by the same means. Winsor, who was a German, returned to England immediately after this, and in 1803 and 1804 publicly exhibited his plan of illumination by coal-gas at the Lyceum Theatre in London. Here he delivered lectures on the subject, which he illustrated by a number of experiments. Among others, he showed the manner of conveying the gas from one part of a house to another; and, by the use of different kinds of burners, he was enabled to display something of that variety of forms which may be given to its flame. Winsor's exhibitions were eminently useful, and tended, in a high degree, to turn public attention to gas-lighting. While he was engaged in exhibiting and lecturing at the Lyceum, he was occasionally subject to great vexations. It is related that he was so unfortunate as to select for his assistants such men as were remarkable for their ignorance rather than for ability or skill, and that scarcely any dependence could be placed upon their attention or diligence. He was also sometimes exposed to their impositions, and being a foreigner, he was under the necessity of engaging a person to read his lectures to his audience. Sometimes, too, when the auditors were assembled his reader failed to appear, and probably had the manuscript lecture in his pocket; and of course they were obliged to retire disappointed and disgusted. The character of

his mechanical assistants was much the same; and they were generally such as to be incapable of rendering him any effective service in his pursuits. These and other mortifying circumstances engaged him in frequent altercations; and he bitterly complains of these disastrous occurrences in his pamphlets. His gas, too, from being burnt in a very impure state, was offensive to the smell, which greatly annoyed his audience; and these circumstances tended to produce a dislike to gas-lighting.

There is no doubt that Winsor's great pretensions also tended to prejudice the public. He was much given to boasting, and he told the world that, by a deposit of five pounds for a share in his National Light and Heat Company, a person might secure a handsome annual income. "All gas-lights," he says in one of his boastful but curious and characteristic addresses to the public, "exhibited before my illuminating the large theatre in the Lyceum early in 1804, I fairly consider as so many Will-o'-the-wisp lights, known for centuries past. The gas of these lights has been caught and collected in bladders, in marshy ground, the same as all coal-gas has hitherto been produced in bladders for philosophical amusement. The principle, that coal and other combustibles contained, among other products, a most beautiful and valuable flame, has been known by the most learned of the last century; but how to make application—how to save and analyze—how to preserve and refine—how to conduct gas in proper air-tight tubes—how to introduce gas-fire and gas-lights into a drawing-room, shop, and street-lamp—how to cook, melt, boil, and distil by a gas-fire, either in a kitchen

or dining-room—how to introduce coke, tar, and ammonial liquor for the advantage of a whole nation—how to make gas-fire and gas-lights applicable to light-houses, telegraphs, and culinary purposes—in fine, how to save and employ all the valuable parts of raw fuel with the greatest possible advantage;—all these most difficult points of my discovery were left a problem to theorists, who could write, but not practise—who could fill bladders from retorts, tobacco-pipes, pots, pans, and gun-barrels with raw smoke, but could not illuminate—whose delicate hands and noses would have shrunk with horror from my numerous dirty and laborious experiments in kitchens and wash-houses, where my own labourers complained of being suffocated, and often refused to assist me, until I shamed them by the example of stripping to perform what they thought was too dirty work for them." And he continues in the following magniloquent strain :—"Animated by the life and example of Peter the Great, emperor of all the Russias, who performed the most abject labours to teach his ministers and generals how to civilize a barbarous nation, I did no longer deem it beneath me (who had been a merchant in the city of London) to do that work which some of my labourers, actually in want of bread, refused to do for victuals and payment."

Notwithstanding these high pretensions, it does not appear that Mr. Winsor ever thought of a plan for storing gas in anything except the main-pipes. In 1807, however, he removed his exhibitions to Pall Mall, and lighted up a part of one side of that street, which was the first instance of this kind of light being applied to such a purpose in London. This practical demonstra-

tion of the practicability of his schemes was of great value in calling further attention to the subject, although the shareholders in the National Light and Heat Company reaped no benefit, and the practical art of making and supplying gas had still many steps to make; but, thanks to the valuable scientific labours of Dr. Henry, and to the practical experiments of Mr. Clegg, a pupil of Boulton and Watt, the cause of coal-gas lighting finally triumphed over all obstacles, including the claims of its rival "oil-gas," which, even as late as 1825, was still preferred by powerful supporters. A charter was granted in 1812 to the company known as the Chartered Gas Company, which was a kind of resuscitation of Mr. Winsor's association; and, in 1816, this company extended mains from their works in the Curtain Road into the City. The opposition to this company was very great. The chief chemists of the day, including Davy and Wollaston, maintained that coal-gas never could be safely applied to street lighting; and Sir Humphrey Davy inquired, ironically, "if it was intended to take the dome of St. Paul's for a gasometer."

From this time, gas-lighting began to extend itself, and, in the course of the following ten years, it had almost entirely superseded the old systems: but the manufacture was still extremely rude. Some terrible accidents in the Chartered Company's Works alarmed the public, and the process was closely watched by Government inspectors. Sir William Congreve, who made a report to Parliament on the subject in 1822, states that he saw two large canvas bags in some works at Whitechapel of about fifteen thousand cubic feet

each, which were for some time used as gas-holders, and lay in close proximity to a blacksmith's forge; and he pointed out the frightful consequences which might ensue "were the tar to be discharged and inflamed, like the emission of a large quantity of burning lava from an artificial volcano." The dread in which the public long regarded the gas companies, and the general tendency to interfere with their operations, could not be better exemplified than by the fact, that a deputation from the Royal Society, headed by Sir Joseph Banks, having visited the gas works of the Chartered Society at Westminster, they strongly recommended the Government to forbid the company constructing gas holders exceeding six thousand cubic feet in capacity, which were to be confined in very strong buildings. Gas-holders are now constructed in the open air, in the midst of the metropolis, made to hold from a quarter of a million to half a million of cubic feet each. Mr. Hollingshead in his work, entitled "Underground London," says "we have now, within the metropolitan area, twenty-three gas manufacturing stations, and six gas-holder stations, used solely for storing gas. The total length of mains laid down by the thirteen companies, in underground London, is seventeen hundred and fifty miles, besides about four hundred and fifty miles of branch service pipes. The house service-pipes, in addition to this, must be at least eight thousand miles long. The total number of London public street lamps supplied with gas is thirty-seven thousand seven hundred and twenty-eight, the average distance from each other being seventy-five yards. The consumption of gas is at least double what it was

ten years ago; and the annual quantity manufactured in London is about eight thousand millions of cubic feet."

TUNNELLING UNDER THE THAMES.

Fifteen years before the commencement of the present Thames Tunnel, Trevithick, the Cornish miner, began an attempt at tunnelling under the River Thames. The idea was not new; for a still more daring experiment had been commenced by an engineer named Ralph Dodd, whose scheme was nothing less than the construction of a tunnel or "archway," under the Thames, from Gravesend to Tilbury, where the breadth of the river is of course far greater than nearer to London. Trevithick, aided by Vasey, another Cornish man, having raised subscriptions, began boring at Rotherhithe; and in order to save expense kept very near to the bottom of the river. Notwithstanding this, his attempt was astonishingly successful, for he actually carried his tunnel a distance of nearly 334 yards, or within thirty-three yards of the entire length proposed to be bored. A surveyor was appointed to report on the progress of the work on behalf of the capitalists who supported it, and unfortunately a dispute arose at this point between Trevithick and this gentleman. The surveyor asserting that the tunnel had run one or two feet out of the direct line, Trevithick is said to have displayed the proverbial irritation of Cornish men. Resolved not to put up with this slur upon his skill as an engineer,

he determined on the ridiculous expedient of actually making a hole in the roof of his tunnel at low water, and thrusting through a series of rods, which he continually lengthened, like the joints of a fishing-rod, which were to be received by a man in a boat, and then observed from the shore. This device proved the ruin of the work. In fitting the rods delays occurred, until suddenly so much water was found to be making its way through the hole, that it became necessary for the engineer and his workmen to retreat. It is related that Trevithick, when the imminent danger became apparent, refused to be the first to leave the works. He sent his men away first, and his life nearly fell a sacrifice to his devotion. Owing to the tunnel following the curve of the bed of the river, the water had congregated towards one point, a fact which, in the confusion of the moment, had not been foreseen; and by the time Trevithick reached the light, the water had actually risen to his neck. Thus by an act of extraordinary imprudence the Cornish engineer's great undertaking came to an end almost at the point of complete success.

The present Thames Tunnel was planned by Brunel in 1823, and in 1824 a company was formed to carry out the work. The simple observation of the habits of a seaworm, known as the *Teredo navalis*, which, in boring into the timbers of a ship, contrives to render the sides of its perforation waterproof by means of a chalky secretion from its own body, suggested to the engineer the idea of his famous "shield." This cast-iron apparatus contained thirty-six cells, in each of which was an excavator, who cut out the earth, while a bricklayer built up from the back of the cell a brick arch, which was pressed for-

ward by screws. But the first step was to sink a brickwork shaft already built, fifty feet in diameter, and forty-two in height, into the ground at 150 feet from the Rotherhithe side of the river. This gigantic labour was accomplished by a powerful steam engine, which raised the earth and drained the water from within; while the brickwork cylinder, which was calculated to weigh one thousand tons, was sunk into the ground. The horizontal tunnel was then commenced from near the bottom of the cylinder at the depth of sixty-three feet from the surface.

The difficulties and dangers encountered in the progress of this work, the frequent breakings in of the water, the suspension and subsequent recommencement of the undertaking, and its final successful completion, for a long time supplied the public with topics of excitement. Sometimes parts of the shield gave way with a noise which resounded through the partly-formed tunnel like a discharge of artillery; then came explosions of gases, momentarily illumining the darkness with sheets of flame, and rendering the workmen insensible.

The roadway was begun on New Year's day, 1826, and upwards of 540 feet had been safely excavated, when on the 18th of May the river burst in. With indomitable patience the engineers filled the aperture with an enormous number of bags of clay sunk in the river, pumped the water out of the tunnel, and resumed the work. Scarcely had they proceeded 150 feet further when the dreaded water again broke in and six men were drowned. The shareholders were now disheartened, but not so the engineers. After a long sus-

pension of the works, a public subscription and a loan from Parliament enabled them to resume them. On the 25th of March, 1843, the tunnel was finally opened to the public.

Many interesting anecdotes are told in connection with the work. A few days previous to the first contest of the bed of the river with the soil, the feed-pipe of one of the boilers of the steam-engine burst. To stop the pumps might have been attended with considerable inconvenience, if not danger. As it chanced, Brunel and his able coadjutor, Mr. Beamish, were on the top of the shaft. Alive to every unusual sound, they ran to the engine-house. Brunel at once perceived the nature of the accident. Seizing some packing and a piece of timber, he jumped upon the boiler, and with wonderful presence of mind applied the packing to the fissure, and one end of the quartering upon that—jamming the other end against the slanting roof of the building. Finding now that the roof was being actually raised, he clasped the quartering, and there hung, like the weight on the safety-valve, until his companion was able to procure sufficient weight to attach to the timber, and relieve him from his perilous situation. By this happy expedient time was fortunately gained, the other boiler was filled, and the steam-engine continued its uninterrupted work.

The following vivid account of one of the irruptions of the river is also given by Mr. Beamish, who was present near the shield under the bed of the river at the time of the accident:—"The miner, Goodwin," he says, "a powerful and experienced man, called for help. For him to have required help was sufficient to indicate danger. I immediately directed an equally-powerful

man, Rogers, to go to Goodwin's assistance; but before he had time to obey the order, there poured in such an overwhelming flood of slush and water that they were both driven out; and a bricklayer, who had also answered to the call for help, was literally rolled over on to the stage behind the frames as though he had come through a mill-sluice, and would have been hurled to the ground if I had not fortunately arrested his progress. I then made an effort to re-enter the frames, calling upon the miners to follow; but I was only answered by a roar of water, which long continued to resound in my ears. Finding that no gravel appeared, I saw that the case was hopeless. To get all the men out of the shield was now my anxiety. This accomplished, I stood for a moment on the stage, unwilling to fly, yet incapable to resist the torrent which momentarily increased in magnitude and velocity, till Rogers, who alone remained, kindly drew me by the arm, and pointing to the rising water beneath, showed only too plainly the folly of delay. Then ordering Rogers to the ladder, I slowly followed.

"As I descended from the stage, the water had so risen in the tunnel that all the loose timber near the frames, the cement boxes, and the large boxes used for mixing the cement, were not only afloat, but in considerable agitation. The light was but barely sufficient to allow me to grope a way through these obstructions, which, striking against my legs, threatened seriously to arrest my progress. I felt that a false step could not be retrieved, clad as I was, and with heavy boots quite full of water. After a short struggle I succeeded in gaining the west arch, which, having been appropriated to visitors, was comparatively free. The water was per-

ceptibly rising; it had already reached my waist; still I could not venture to run, feeling that a stumble might yet prove fatal. If I could only gain the barrier which limited the ingress of visitors, I should be clear of the floating timber which must be there arrested. As I approached this barrier, the sight of some of our most valued hands cheered me. Not understanding the cause of procrastination, they could not withhold their expressions of impatience. Arrived at the barrier, four powerful hands seized me, and in a moment placed me on the other side. On we now sped. At the bottom of the shaft we met Isambard Brunel and Mr. Gravatt. We turned. The spectacle which presented itself will not readily be forgotten. The water came on in a great wave, everything on its surface becoming the more distinctly visible as the light from the gas lamps was more strongly reflected. Presently a loud crash was heard. A small office which had been erected under the arch, about a hundred feet from the frames, had burst. The pent air rushed out; the lights were suddenly extinguished; and the noble work which only a few short hours before had commanded the homage of an admiring public, was consigned to darkness and solitude.

"It only remained to ascend the shaft, but this was not so easy. The men filled the staircase; being themselves out of danger, they entirely forgot the situation of their comrades below. For the first time I now felt something like fear, as I dreaded the recoil of the wave from the circular wall of the shaft, which, if it had caught us, would inevitably have swept us back under the arch. With the utmost difficulty the lowest flight of steps was cleared, when, as I had apprehended, the

recoil came, and the water surged just under our feet. The men now hurried up the stairs, and though nearly exhausted, I was enabled to reach the top, where a new cause of anxiety awaited us. A hundred voices shouted, 'A rope! a rope! save him! save him!' How any one could have been left behind puzzled and pained me sorely. That some one was in the water was certain. With that promptitude which ever distinguished Isambard Brunel, he did not hesitate a moment. Seizing a rope, and followed by Mr. Gravatt, he slid down one of the iron ties of the shaft. The rope was quickly passed round the waist of the struggler, who proved to be old Tillett, the engineman. He had gone to the bottom of the shaft to look after the pumps, and being caught by the water was forced to the surface, from which he would speedily have disappeared, but for the presence of mind and chivalrous spirit of his officers.

"The roll was now called, when, to our unspeakable joy, every man answered to his name; and we were thus relieved from the painful retrospect that must have followed any sacrifice of life."

Frequent troubles were experienced from the use of the diving-bell. Links in the chain by which it was suspended gave way, and occasionally vessels in the crowded river ran foul of the bell barge, sending it adrift. Underground imaginary alarms frequently added to the troubles of the miners. One of these was of a somewhat ludicrous character. Besides the watch in the tunnel, it was customary to place a watchman at the entrance, near the "weir," by which the quantity of water coming from the working was measured; and one Saturday night this important

duty was assigned to the faithful Rogers. Suddenly at about three o'clock in the morning he was startled by the terrible words, issuing in a loud tone from the tunnel, of "Wedges! clay! oakum! The whole of the faces coming in. Coming altogether." Recognizing the voice of Fitzgerald, the foreman bricklayer, one of the watch, Rogers himself gathered together some wedges and timber, and made his way to the frames, expecting to find there all terror and confusion; but he saw nothing strange, and could hear nothing more ominous than the customary sound of pumping. He then examined every top box where it was the duty of the men to keep watch, but there was no appearance of any movement. The idea flashed across his mind that all had been drowned, when, to his astonishment and relief on mounting a stage near the west arch, he found the whole of the watchmen comfortably asleep on clean straw. Fitzgerald, who was of the number, had been naturally dreaming of the dangers which were ever about them day and night, and the exclamations which had caused so much alarm had been uttered by him in this condition, and re-echoed through the tunnel till they reached his brother watcher.

The total cost of the Thames Tunnel was about £454,000. As a commercial speculation it was entirely unsuccessful; the carriage descents were never completed; the foot-passenger traffic has never been sufficient to yield any considerable profit; and at this moment it is in contemplation to convert this extraordinary work into a tunnel for a railway.

THE IDEA OF THE THAUMATROPE.

ACCORDING to a story in Mr. Babbage's interesting "Passages from the Life of a Philosopher," the idea of this beautiful philosophical toy is due to the astronomer Herschel and his friend Dr. Fitton. "One day," says Mr. Babbage, "Herschel, sitting with me after dinner, amusing himself by spinning a pear upon the table, suddenly asked whether I could show him the two sides of a shilling at the same moment.

"I took out of my pocket a shilling, and holding it up before the looking-glass, pointed out my method. 'No,' said my friend, 'that won't do;' then spinning my shilling upon the table, he pointed out his method of seeing both sides at once. The next day I mentioned the anecdote to the late Dr. Fitton, who a few days after brought me a beautiful illustration of the principle. It consisted of a round disc of card suspended between the two pieces of sewing silk. These threads being held between the finger and thumb of each hand, were then made to turn quickly, when the disc of card, of course, revolved also.

"Upon one side of this disc of card was painted a bird; upon the other side, an empty bird-cage. On turning the thread rapidly, the bird appeared to have got inside the cage. We soon made numerous applications, as a rat on one side and a trap upon the other, etc. It was shown to Captain Kater, Dr. Wollaston, and many of our friends, and was, after the lapse of a short time, forgotten.

"Some months after, during dinner at the Royal Society Club, Sir Joseph Banks being in the chair, I heard Mr. Barrow, then Secretary to the Admiralty, talking very loudly about a wonderful invention of Dr. Paris, the object of which I could not quite understand. It was called the thaumatrope, and was said to be sold at the Royal Institution, in Albemarle Street. Suspecting that it had some connection with our unnamed toy, I went the next morning and purchased, for seven shillings and sixpence, a thaumatrope, which I afterwards sent down to Slough to the late Lady Herschel. It was precisely the thing which her son and Dr. Fitton had contributed to invent, which amused all their friends for a time and had then been forgotten. There was, however, one additional thaumatrope made afterwards. It consisted of the usual disc of paper. On one side was represented a thaumatrope (the design upon it being a penny-piece), with the motto, 'How to turn a penny.' On the other side was a gentleman in black, with his hands held out in the act of spinning a thaumatrope, the motto being, 'A new trick from Paris.'"

THE PIANOFORTE.

The introduction into this country of the pianoforte—that favourite instrument which is now found in every household where a taste for music exists—may almost be said to have taken place within the memory of living persons. As early as 1716 an inventor, named Marius,

presented to the Academy of Sciences in Paris a clavecin, whose strings were vibrated with hammers instead of plectrums; and two years later, Christoforo, a Florentine musical-instrument maker, devised some further improvements on the instrument. This has generally been considered as the first piano. In 1760 a foreigner, named Zumpe, established in England a small manufactory of these instruments; but he met with little success. Its merits were, however, clearly perceived by Haydn, who left sixty sonatas composed expressly for it; Gluck also adopted the new invention, and the piano on which he composed his "Armida," and other works, made for him by John Pohlman in 1772, still exists. It is stated to be only $4\frac{1}{2}$ feet in length, and 2 feet in width, with a small square sounding-board at the end, the wire of the strings being little more than threads, and the hammers consisting of a few piles of leather over the end of a horizontal jack working on a hinge. "The instrument," says M. Thalberg, "compared with a fine piano of the present day, is utterly insignificant and useless; and it is difficult to conceive how it could have been used for the purposes it certainly served, till we reflect upon the importance to the composer of having at instant command any description of orchestral effect."

In France the first maker of a pianoforte was Sebastien Erard, who died in Paris in 1831. Erard was the orphan child of a cabinet-maker in Strasbourg. He came to Paris when only sixteen years of age, and apprenticed himself to a harpsichord maker, in whose employment his ingenious mind soon found means to display itself. His apprenticeship being ended, the

young Strasbourg workman obtained employment from various instrument-makers, which he executed at his own house. One day a harpsichord-maker, struck by his talent, proposed to him to make an instrument of the harpsichord kind, with such improvements as the workman could suggest. Pleased with his task, although it was agreed that the instrument was to bear the name of his master only, who proposed to take the credit of the work, Erard devoted himself assiduously to the production of the instrument. When it was completed, the musician who had purchased it was so much struck with its powers that he returned to make inquiries from the harpsichord-maker on the subject of its construction. The man, taken by surprise, was unable to reply, and was at length compelled to admit that it was entirely the work of his young journeyman. From that time Erard's reputation began to spread. The Duchess de Villeroi, who devoted much of her fortune to the encouragement of the arts, having heard of the young artist, sent for him, and proposed to him to attempt the construction of a piano similar to those recently introduced into Saxony by Silberman; and it was in her house in Paris that the workman designed and completed his instrument—the first ever made in France, where, indeed, it was till then almost entirely unknown. Played at the concerts given by the Duchess, the instrument quickly gained in favour.

Sebastien Erard, in conjunction with his brother Jean Baptiste, set up a manufactory in Paris to meet the demand for the instrument; and here the ingenuity of the Strasbourg workman speedily introduced such important improvements that his instruments became

famous throughout Europe. It is said that an agent in Hamburgh, in the year 1799, sold in that city more than two hundred of Erard's pianos. It is to the Erard establishment that the pianoforte players owe the upward bearing of the strings—a great improvement, now almost universally adopted.

THE ECCENTRICITIES OF THE HON. HENRY CAVENDISH.

The passion, in certain minds, for scientific discovery, was perhaps never more curiously illustrated than in the account of the death of the Honourable Henry Cavendish, the natural philosopher. Cavendish, who died in 1810, in his seventy-ninth year, was a man of remarkably strong constitution. It is said that the illness which caused his death was the first as well as the last under which he suffered. Aware of the gravity of his situation, he determined to mark accurately the progress of his disease, and the gradual diminution of the vital powers. For this purpose, and in order that his attention might not be disturbed, he desired to be left alone. His servant returning to his master's bedroom sooner than he was ordered to do, his master, though then in a sinking state, desired him to leave him again. When the man came back a second time he found that his master had expired.

Cavendish's first scientific publication was a paper on Factitious Airs, which, for the first time, gave a dis-

tinct account of the properties of hydrogen and of carbonic acid gas. He subsequently devoted himself to natural philosophy generally; and published, in 1776, a curious account of his attempts to imitate the electrical eel by an apparatus constructed in imitation of the living fish in connection with a Leyden battery, by which he removed all doubts as to the identity of the benumbing power of the torpedo with common electricity. His discoveries concerning the composition of the atmosphere, the compound nature of water, and of the composition of nitric acid, and the density of the earth, place him in the highest rank of English philosophers. In order to solve the question of whether the atmosphere is constant in its composition, he made many hundred analyses of air.

This singular man, who was remarkable for his profound and original knowledge in almost every department of physical science, is described as living entirely apart from the world among his books and his scientific apparatus; never taking part in the affairs of active life, but passing his whole time in his favourite pursuit of scientific truth. His dress was always antiquated, his walk quick and ungraceful; he never appeared in the metropolis except lying back in his carriage, and it is remarked that he probably uttered fewer words in the course of his life than any man who ever lived to nearly fourscore. An admirer alluding to his large fortune, said that he was "the richest of all wise men, and probably the wisest of all rich men." He does not, however, appear to have been free from grave defects. His biographer, Dr. George Wilson, gives the following curious summary of his private character:—

"Morally it was a blank, and can only be described by a series of negations. He did not love, he did not hate, he did not hope, he did not fear, he did not worship as others do. He separated himself from his fellow men, and apparently from God. There was nothing earnest, enthusiastic, heroic, or chivalrous in his nature; and as little was there anything mean, grovelling, or ignoble. He was almost passionless. An intellectual head thinking, a pair of wonderfully acute eyes observing, and a pair of very skilful hands experimenting or recording, are all that I recognize in his memorials. His brain seems to have been but a calculating engine; his eyes inlets of vision, not fountains of tears; his hands instruments of manipulation, which never trembled with emotion, or were clasped together in adoration, thanksgiving, or despair; his heart only an anatomical organ necessary for the circulation of the blood. A sense of isolation from his brethren made him shrink from their society and avoid their presence; but he did so as one conscious of an infirmity, not boasting of an excellence. He was like a deaf mute, sitting apart from a circle whose looks and gestures show that they are uttering and listening to music and eloquence, in producing or welcoming which he can be no sharer. Wisely, therefore, he dwelt apart. He was one of the unthanked benefactors of his race, who was patiently teaching and serving mankind, whilst they were shrinking from his coldness or mocking his peculiarities. He could not sing for them a sweet song, or create a 'thing of beauty,' which would be 'a joy for ever,' or touch their hearts, or fire their spirits, or deepen their reverence or their fervour. He was not a poet, a priest, or a prophet,

but only a cold clear intelligence, raying down pure white light, which brightened everything on which it fell, but warmed nothing—a star of at least the second, if not of the first magnitude in the intellectual firmament."

All this appears to be fully borne out by the testimony of those who knew him. In spite of his recluse habits and dread of becoming famous, Cavendish's reputation spread rapidly. About the year 1785, when his chief discoveries were made, his town residence was at the corner of Montague Place and Gower Street. Of this and other houses of Cavendish, Dr. Wilson says, "Few visitors were admitted, but some found their way across the threshold, and have reported that books and apparatus formed its chief furniture. For the former, however, Cavendish set apart a separate mansion in Dean Street, Soho. Here he had collected a large and carefully chosen library of works on science, which he threw open to all engaged in research, and to this house he went for his own books as one would go to a circulating library, signing a formal receipt for such of the volumes as he took with him. His favourite residence was a beautiful suburban villa at Clapham, which, as well as a street or row of houses in the neighbourhood, now bears his name. . . . A small portion only of the villa was set apart for personal comfort. The upper rooms constituted an astronomical observatory. What is now the drawing-room was the laboratory. In an adjoining room a forge was placed. The lawn was invaded by a wooden stage, from which access could be had to a large tree, to the top of which, in the course of his astronomical, meteorological, electrical, or other researches, he occasionally ascended."

Cavendish lived comfortably, but made no display. His few guests were treated on all occasions to the same fare, and it was not very sumptuous. A Fellow of the Royal Society reports that if any one dined with Cavendish, "he invariably gave them a leg of mutton and nothing else." Another Fellow states that Cavendish "seldom had company at his house; but on one occasion three or four scientific men were to dine with him; and when his housekeeper came to ask what was to be got for dinner, he said, 'A leg of mutton.' To the servant's remonstrance that that would not be enough for five, he replied, 'Well then, get two!'"

Dr. Thomas Thomson gives the following account of Cavendish:—"He was shy and bashful to a degree bordering on disease. He could not bear to have any person introduced to him, or to be pointed out in any way as a remarkable man. One Sunday evening he was standing at Sir Joseph Banks' in a crowded room conversing with Mr. Hatchett, when Dr. Ingenhousz, who had a good deal of pomposity of manner, came up with an Austrian gentleman and introduced him formally to Mr. Cavendish. He mentioned the titles and qualifications of his friend at great length, and said that he had been peculiarly anxious to be introduced to a philosopher so profound and so universally known and celebrated as Mr. Cavendish. As soon as Dr. Ingenhousz had finished, the Austrian gentleman began, and assured Mr. Cavendish that his principal reason for coming to London was to see and converse with one of the greatest ornaments of the age, and one of the most illustrious philosophers that ever existed.

"To all these high-flown speeches Mr. Cavendish

uttered not a word, but stood with his eyes cast down, quite abashed and confounded. At last, spying an opening in the crowd, he darted through it with all the speed of which he was master, nor did he stop till he reached his carriage, which drove him directly home."

Sir Humphrey Davy, who could well appreciate the great discoveries of Cavendish, says, "He was a great man, with extraordinary singularities. His voice was squeaking, his manner nervous; he was afraid of strangers, and seemed when embarrassed even to articulate with difficulty; he wore the costume of our grandfathers. . . . He gave me once some bits of platinum for my experiments, and came to see my results on the decomposition of the alkalis, and seemed to take an interest in them, but he encouraged no intimacy with any one. . . . He was acute, sagacious, and profound, and, I think, the most accomplished British philosopher of his time." Another writer who knew him well—Mr. J. G. Children—says, "When I first became a member of the Royal Society Club, I recollect seeing Cavendish on one occasion talking very earnestly to Marsden, Davy, and Hatchett. I went up and joined the group. My eye caught that of Cavendish, and he instantly became silent; he did not say a word. The fact is, he saw in me a strange face, and of a strange face he had a perfect horror. I don't think I had been introduced to him, but I was so afterwards, and then he behaved to me very courteously. Lord Burlington informed Dr. Wilson, on the authority of Mr. Allnutt, an old inhabitant of Clapham, that Cavendish would never see a female servant, and if an unfortunate maid ever showed herself, she was immediately

dismissed." Lord Brougham says that Cavendish ordered his dinner daily by a note, which he left at a certain hour on the hall table, where the housekeeper was to take it; for he held no communication with his female domestics. It is probable that these habits grew upon him; and that the anecdote of the leg of mutton, related by Dr. Wilson, referred to an earlier period of his life.

When Cavendish died, a discovery was made, which may well excite the imaginations of the romantic on the causes of his singular retirement and misanthropy. According to Sir J. Barrow, in one of his chests of drawers were discovered parts of richly-embroidered lady's dresses, and among other valuable articles, an old but magnificent stomacher, so beset with diamonds that when it came to be examined and valued, its worth was found to be nearly twenty thousand pounds.

Cavendish was the younger son of Lord Charles Cavendish, and grandson of the second Duke of Devonshire. Notwithstanding his lonely way of life, he is said to have shown himself in many respects a kindly and a liberal man. So simple, however, was his mode of living that his fortune greatly increased throughout his life; and when he died he was found to have bequeathed the enormous sum of twelve hundred thousand pounds for division among his relatives and friends.

WILLIAM MURDOCH AND HIS INVENTIONS.

Mr. Murdoch, whose name is best known as one of the earliest of those who applied coal-gas to useful purposes, was the inventor of a great number of ingenious appliances. The son of an Ayrshire millwright, he settled at Birmingham, where his talents were discovered by Messrs. Boulton and Watt, who appointed him to undertake the charge of their new steam engines at Redruth, in Cornwall. Here Murdoch resided for nineteen years. A paper read by Mr. William Buckle, of Soho, before a meeting of the Institution of Mechanical Engineers, gives some interesting particulars of his sojourn in this part, where he gave so much satisfaction to the mining interest, that when his determination to return to Soho became known, they offered him £1000 a year to remain in Cornwall. During his residence there (says Mr. Buckle) Murdoch contrived and executed a model locomotive, which, as early as the year 1784, he was in the habit of showing to his friends in working order, and drawing a small waggon round a room in his house at Redruth. He used to tell a story, that while making experiments with this engine, he one night determined to test its powers on a level road leading from his house to the church, which was situated about a mile distant from the town; this road was bounded on each side by high edges, and well suited for the purpose. Murdoch accordingly sallied out, and placing his engine on the ground, lit the fire, or rather

lamp, under the boiler; after a few minutes off started the locomotive with the inventor full chase after it. After continuing the pursuit for a short distance, he heard cries as of a person in great distress; the night was too dark to perceive objects afar off, but on going on, he found that the sounds proceeded from the clergyman of the parish, who had set out for the town on business, and being met on this lonely road by the fiery monster, had taken it for the Evil One in person. This model locomotive was exhibited before a meeting of the Institution of Mechanical Engineers in 1850, sixty-six years after the date of its construction.

Returned to Soho, Mr. Murdoch soon became one of the most conspicuous of the circle of scientific and ingenious men who were associated directly and indirectly with Watt and Boulton. His experiments with gas probably did more to strike the popular mind with the importance of that remarkable theatre for the display of new inventions than all the marvels of the steam engine. Murdoch took out a patent for improvements in boring cylinders and in the manufacture of steam casings; this patent also included the double slide valve and a rotary engine. Amongst other inventions and discoveries of Murdoch's (says Mr. Buckle) are: a plan for boring stone pipes for water, and cutting columns out of solid blocks of stone (for which he took a patent in 1810); a pneumatic lift working by compressed air; and a cast iron cement, which he was led to discover by the accidental observance of some iron borings and sal-ammoniac, which had got mixed in his tool-chest and rusted a sword blade nearly through. He also made use of compressed air to ring the bells in his house; a

plan which so pleased Sir Walter Scott, to whom it had been described, that he had his house at Abbotsford fitted up in a similar manner.

Murdoch likewise discovered a substitute for isinglass, and when in London, for the purpose of explaining to the brewers the nature of his discovery, he occupied very handsome apartments. Being, however, at all times absorbed in whatever subject he had in hand, he little respected the splendour of his drawing-room, but proceeded with his experiments as if in the laboratory at Soho, quite unconscious of the mischief he was doing. This resulted in his abrupt dismissal from the apartments by the enraged landlady, who one morning, on calling in to receive orders, was horrified at seeing all her magnificent paper-hangings covered with wet fish skins hung up to dry, and actually caught him in the act of pinning up a cod's skin to undergo the same process.

Mr. Murdoch met with an unfortunate accident in the year 1815, from the effects of which he never entirely recovered. While fitting up an apparatus of his own invention for heating the water of the baths at Leamington, a heavy plate of cast iron fell upon his leg above the ankle, nearly severing it in two. He lived, however, till 1839, when he died at Handsworth in his eighty-sixth year. His remains were deposited in Handsworth church, near to those of his old friends and fellow-workers, James Watt and Matthew Boulton.



PRINCE ALBERT AND THE INVENTOR OF GUN COTTON.

PRINCE ALBERT AND THE INVENTOR OF GUN-COTTON.

Professor Schönbein, of Basle, discovered that by combining cotton with nitric acid, an explosive compound was formed capable of being substituted for gunpowder. Gun-cotton is remarkable for the low temperature at which it explodes. Hence, when pure, it may be burnt on the palm of the hand, without inconvenience, on the application of a heated wire. When this discovery was first announced in England in 1846, Professor Schonbein attended at Osborne House, in the Isle of Wight, to exhibit the properties of his gun-cotton to the late Prince Consort. Schönbein offered to explode a portion on the hand of one of the company, who was a military officer. The officer, however, declined to have anything to do with the experiment; but the Prince smiling offered his hand to submit to the test. The wire was applied, and the cotton ignited without stain or burning of the skin. Thus encouraged, the officer took his turn; but by some accident the experiment this time proved more disagreeable, and caused him so much pain that he leaped up with a sudden cry. As the injury, however, proved trifling, a hearty laugh from the company was all the commiseration he received. After this, Professor Schönbein loaded a fowling-piece with cotton in the place of powder, and the Prince fired both ball and shot from it with the usual effect. Dissolved in ether, gun-cotton forms the collodion now extensively employed in photography. Collodion is also used by sur-

geons as affording a ready and efficacious plaster for cuts and flesh wounds.

Some practical objections to the use of gun-cotton have hitherto prevented its superseding gunpowder; but in consequence of the recent improvements of Baron Lenk, renewed attempts are being made to introduce it into general use. Some of its properties are extremely curious, and would appear to fit it in a high degree for purposes for which gunpowder is employed. The explosion from it causes no smoke. It does not foul the gun, or heat it, or cause so great a recoil as is caused by gunpowder. In all blasting in mining operations, the absence of smoke is of course a great advantage. Its weight is only one-sixth of that of gunpowder. But one of its most remarkable qualities is that time, damp, and exposure do not affect its qualities. By simply wetting it, the cotton can be carried through fire without injury, and on being afterwards dried in the open air, it becomes as good as ever. The original gun-cotton was in the form of light cotton wool; the latest, and it is believed more practical modification, is in the shape of rope or yarn.

THE LABOURS OF SIR JOSEPH BANKS.

Sir Joseph Banks, whose discoveries in natural history place him in the highest rank among English scientific men, was noted when a boy for his immoderate love of play and disinclination to study. When at Eton, at the age of fourteen, his tutor was one day surprised to find

him reading, in his leisure hours, an imperfect copy of "Gerard's Herbal," which he had carried away from home. Banks afterwards said, in allusion to this period, that one fine summer evening he had been bathing in the river with other boys, but having remained a long time in the water he found, when he came to dress himself, that all his companions were gone. Returning home alone, and walking leisurely through a lane, the banks of which were covered with wild flowers, he was struck with their beauty; and the idea occurred to him that to study their characteristics would be far more interesting to him than poring over Greek or Latin exercises. Pleased with the notion, he immediately began to teach himself botany; and for want of better instructors was accustomed to ramble about on holidays with women employed to gather simples for the druggists and apothecaries, for whom he occasionally obtained information on their habits and localities. Banks told Sir Everard Home that when he first came to Oxford, if he happened to join any party of students who were discussing questions respecting Greek authors, some of them would call out, "Here is Banks; but he knows nothing of Greek." To this rebuke he made no reply but said to himself, "I will very soon excel you all in another kind of knowledge, to my mind of infinitely greater importance;" and not long after, if any of them wanted to clear up a point of natural history, they were accustomed to say, "Now we must go to Banks."

In pursuit of his favourite science, Banks herbalized much on foot; and being somewhat careless of his personal appearance, he was often mistaken for a vagrant. On one occasion, worn out with fatigue and soiled with

his labours in the woods, he lay down to sleep at a little distance from the high road with his collection of specimens by his side, and being found there by a parish constable, he was taken, in spite of remonstrances, before a Justice of the Peace. A few explanations, of course, procured his dismissal. Banks made many voyages to distant countries in pursuit of new discoveries—remaining abroad two or three years at a time, encountering numerous perils and hardships. Many plants and animals hitherto unknown were brought by him to Europe. He accompanied Captain Cook on his fourth expedition round the world, aboard the "Endeavour," which arrived in England, after an absence of three years, in June, 1771. The people received the voyagers on this occasion with rejoicings, and the king showed his esteem for Banks on many occasions. Banks afterwards became President of the Royal Society, and was invested by the king with the Order of the Bath, and admitted a member of the Privy Council. His enlarged and liberal views on international obligations are thus noticed by Cuvier:—

"At the breaking out of the American war, Louis XVI. gave orders that his vessels should everywhere show respect to Captain Cook and his companions. To the honour of the age we live in, reviled and contemned as it has been, be it said that this noble example has become an article in the laws of nations; but it is chiefly to the constant zeal of Banks that we owe this great boon. Not only did he never lose an opportunity of getting the English government to comply with it, but more than once he even succeeded in persuading foreign governments to conform to it. From the first breaking

out of the war which desolated Europe, he procured similar orders to be issued in favour of La Perouse, if he still existed; and he caused inquiries to be made for him in every sea. When discord had terminated the expedition of D'Entrecasteaux, and when the collections of M. de la Billardière were transported to England, he succeeded in procuring them to be given up to him; and not only did he hasten to restore them to their owners, but he accompanied his bounties with the singular delicacy of returning them unopened. He wrote to Jussieu that he would not carry off a single idea from a man who had procured these collections at the peril of his life."

On no less than ten different occasions, collections addressed to the Jardin du Roi, which had been captured by English vessels, were recovered by him, and restored in this manner. He even sent as far as the Cape of Good Hope to procure some chests belonging to Humboldt, which had been seized by pirates; and on all these occasions he would accept no reimbursement. He appeared to feel that he was, as it were, answerable for the outrages committed by his country on science and the arts, and that it was almost his duty to repair the injuries done by other nations to science. Having learnt from the newspapers that Broussonnet had been obliged to fly from his country in order to save his life, Sir Joseph Banks gave orders to his correspondents in Spain to supply all his wants; and a friendly hand and an open purse awaited him at Madrid, and again at Lisbon, and followed him as far as Maroc. When the distinguished mineralogist Dolomière, by the most unjust violation of the laws of nations, in order to gratify the vengeance of an angry woman, was cast into

the dungeons of Messina, it was the ingenious humanity of Banks that first penetrated the subterranean prison, where, concealed from all mankind, he languished in despair, and whispered solace to his affliction, and gave him tidings of his country and of his family; and if his benefactor did not succeed in procuring him his liberty, it was not for want of zeal in attempting all possible means with the government that so unjustly detained him. The zeal which Banks displayed for the scientific sons of France was not less exerted for his own countrymen. When by a violation of the rights of nations, thousands of Englishmen, resident or travelling in France, were suddenly declared prisoners of war, Banks hastened to discover all those in whose favour some scientific occupation or title could be alleged, and he called upon the Institute of France to assist him in supporting his demand for their liberation, and the Institute did not examine with very nice care the claims advanced in favour of the liberation of numerous persons. By these means many were released from a captivity that might have proved fatal.

Sir Joseph Banks, says one who knew him, was in person tall and manly, with a countenance expressing dignity and intelligence. His manners were polite, his conversation rich in instructive information. On most subjects he exercised the discrimination of an original and vigorous mind. His knowledge was not that of facts merely, or of technical and complex abstractions alone, but of science in its elementary principles, and of nature in her happiest forms. He died on the 19th of June, 1820, at the age of seventy-seven, at his house at

Spring Grove, near Hounslow, leaving an immense collection of specimens, and a very extensive library, which he bequeathed to the British Museum.

MODERN LAMPS AND THEIR INVENTORS.

WHILE the last eighty years have seen the invention and introduction of gas-lighting in our streets, shops, and manufactories, scarcely less striking improvements have been effected in our domestic lamps—those indispensable companions of the student and the workman, whose occupation requires a steady light. From a very early time men had discovered that certain substances plunged into oil or enveloped in grease, would burn slowly and give light. But the ancient modes of employing these devices were far from satisfactory. They furnished a dim light, annoying the senses and injuring articles of furniture by giving out constantly thick clouds of smoke. Up to the beginning of the present century the expensive wax candle was the only means practically in use for lighting a room without the inconvenience of smoke. It was in 1785 that Argand, a native of Geneva, discovered a new and simple method of obviating this objection to lamps while giving to their flame for the first time a pure and brilliant appearance. It was Argand who first thought of the device of cylindrical necks, to the top of which the oil was induced to ascend through a tube or by the capillary attraction of the wick. Argand knew that the air passing con-

tinually up this wick in two currents, the one external, the other internal, would afford a far more abundant supply than could be obtained by the old methods, and thus feed the flame with such rapidity as to prevent smoke; but the crowning point of his invention was the glass chimney, the draught and heat created by which enabling the oil to burn at a much higher temperature, gave at once that clearness and intensity to the light which is now familiar in all households. While Argand was preparing to apply this important discovery, a workman named Quinquet, left his service, and immediately afterwards brought out an improvement as entirely his own invention. As such the public received it, and for a long time Quinquet's name became thus unjustly associated with the ingenious discoveries of his former master.

Argand died in 1803. He had lived to see considerable improvements in the useful instrument which bears his name. For the chief of these the world is indebted to Carcel, the clockmaker of Paris. To him we owe the solution of an important difficulty in lamp making —the avoidance of the projection of the shade from the reservoir. An interesting article descriptive of Carcel's invention has been published in the "Engineer," weekly journal, from which we extract the following particulars:—"In a lamp which he constructed, Carcel made the reservoir for oil at the lower part of the lamp, and placed close to it a clockwork which moved a little force pump, the piston of which raised the oil as far as the wick. The spring was reached by means of a key. The mechanical means employed by Carcel for raising the oil to the burner were as ingenious as elegant; there-

fore we have changed nothing of the principle of the inventor's lamp. The wheel-work that he adopted has always been retained; the improvements being secondary points in the mechanism. Carcel drew but a small profit from his important discovery. Like many originators of useful inventions, to whom we are indebted for the luxury and ease of actual life, he left to others the profits and benefit of his works. He died in 1812 full of infirmities. Life had been to him but a long and painful struggle. When he wished to patent and secure to himself the property of his discovery, and to commence the use of it, he was obliged to have recourse to a partner to find the necessary funds. It was the apothecary Carreau who joined him: thus the patent, which was delivered the 24th of October, 1800, to the inventor of the Mechanical Lamp, bore the two names of Carcel and Carreau. But the latter had nothing to do with the discovery, though his intervention in the enterprise was not without its advantages. Carcel, greatly discouraged, would not have followed up the work he had proposed to himself, had it not been for the entreaties and encouragement of his friend. However, the term of the patent expired without having brought any important profit to the two partners. In the Rue de l'Arbre Sec at Paris may still be seen the old shop of Carcel, occupied to this day by a member of his family, bearing this sign, 'Carcel, Inventeur.' In the doorway of this simple shop may be seen the first model of the lamp which Carcel constructed. The hot air which passes from the glass chimney of the lamp serves to put in motion the mechanism by which the oil is raised to the burner. On other lamps is clockwork,

constructed as by Carcel, the needles of which are put in action by the same mechanism which raises the combustible liquid."

MR. MALLET'S DISCOVERIES ABOUT EARTHQUAKES

It is only within the last few years that any strictly scientific attempt has been made to discover the nature of earthquakes. For this important scientific movement the world is indebted to Mr. Robert Mallet, the engineer, who had long made experiments on the nature of earth-waves during explosions of gunpowder, and in other matters connected with this subject. Impressed with the belief that in this, as in all other branches of natural philosophy, diligent and systematic inquiry must lead to the discovery of important truths, Mr. Mallet determined to extend his researches, as opportunity offered, into the phenomena of these terrible convulsions of nature which have so long afflicted some of the finest regions of the earth.

The subject was at length taken up by the British Association for the Advancement of Science, who granted a considerable sum of money from the funds of the Association for the purpose of investigating earthquake phenomena. A voluminous catalogue of nearly seven thousand earthquakes was compiled and published, and Mr. Mallet was entrusted with the task of drawing up reports of the results, and in Mr. Mallet's hands

seismology, or the knowledge of earthquakes (from a Greek word, signifying an earthquake), has become a distinct branch of science.

In 1857 Mr. Mallet volunteered to investigate the phenomena of the great Neapolitan earthquake of that year, one of the most terrific that had ever devastated Italy; and after great labour and perseverance he prepared an elaborate report upon the subject, abounding in information of great importance to all persons living in regions liable to these disastrous shocks. On minutely observing, by the aid of a compass, the direction in which buildings and other objects were cast down, Mr. Mallet was enabled not only to determine the exact course of the earth-waves, but to ascertain the laws which govern them. Among the most useful of his discoveries, was that of the best form of building for resisting the shocks. He found that buildings with vaulted and domed roofs, so common in those parts, were particularly subject to disaster during the shocks. He showed, for the first time, the fallacy of the common belief in the formation during earthquakes of fissures of fathomless depth, and was enabled to pronounce the story of the great Jamaica earthquake having opened and closed with the earth-wave, and bitten people in two, as a mere fable. Mr. Mallet next proceeded, by a series of laborious experiments, to determine the locality of what he calls the earthquake's focus, and then to ascertain its depth. The latter he was led to conclude did not exceed three geographical miles. The average rate of travelling of the earth-wave on the surface he found to be about 788 feet per second. But perhaps the most valuable of his discoveries was that of the fact

that the great centres of earthquake intensity are slowly but continually moving in one direction—a fact which Humboldt had suspected in South America. It is not too much to hope that the ultimate fruits of these discoveries may enable the inhabitants of countries subject to these awful visitations to anticipate with certainty the locality and line of movement of earthquakes, and so in great degree to avoid their disastrous effects.

TIME AND SPACE ABOLISHED.

Some time ago, in accordance with a previous arrangement, the *employés* of the American Telegraph Company's lines between Boston and a town in the State of Maine, held a meeting by telegraph, after the business of the line was concluded for the day, to take action upon the resignation of a superintendent. A curious account of this meeting was given in an American scientific Journal. Thirty-three offices were represented, scattered over a circuit of seven hundred miles, and speeches were made by most of their representatives. Each speaker wrote with his key what he had to say, and all the offices upon the line received his remarks at the same moment, thus abolishing space and time, and bringing the different parties, in effect, as near to each other as though they were in the same room, although actually separated by hundreds of miles.

An account of the first game of chess ever played in

England was published in the "Illustrated London News," for the 12th of April, 1845. It was played between amateurs in London, and Mr. Staunton and Captain Kennedy in Gosport. It was intended at first that this novel contest should take place between two persons only, as in an ordinary game over the table—one stationed at London and the other at Gosport; but as no player could be found who was willing to cope with Mr. Staunton single-handed, it was at length arranged that, in conjunction with Captain Kennedy, he should conduct the game at one terminus against half a dozen of the ablest players in the kingdom at the other. To obviate other difficulties, as to which parties should take the distant end, etc., Mr. Staunton volunteered himself to play at Gosport. Accordingly, on the day appointed, he took his station, with his ally, at the chess-board in the telegraphic apartment at Gosport; while his opponents, surrounded by a numerous assemblage, consisting of friends of the directors and persons eminent in science, art, and literature, were at their post in the saloon of the terminus at Vauxhall. The contest began about half-past eleven A.M., and terminated about seven in the evening—nearly the whole of this time being occupied by the consideration of the players over their moves; the mysterious messenger who conveyed the intelligence performing his noiseless journey with the speed of thought.

The mode of playing was by numbering the squares of the chess-board and the men; thus the moves were conveyed; and the mysterious messenger imparting the intelligence, must have travelled backward and forward during the game, upwards of 10,000 miles.

The telegraph was not solely devoted to the game, but throughout the day it conveyed various messages. Forty-three moves were made on each side, and the result was a drawn game. The contest would not have lasted so many hours if it had not been for the time lost in telegraphing the moves from Gosport to Southampton as well as to London.

THE RESTORER OF WOOD ENGRAVING.

Up to a period less than a century ago wood engraving had fallen to so low an ebb as to have been almost a lost art. The acknowledged restorer of this art, which has now become of such vast importance, was the well-known Thomas Bewick, who was born at Cherryburn in Northumberland in 1753.

Bewick's first tendency to drawing was noticed by his chalking the floors and grave-stones with fantastic figures, and by sketching the outline of any known character of the village, or of dogs or horses, which were instantly recognized as faithful portraits. The halfpence he thus obtained were laid out in chalk and pencils, with which, when taken to church, he scrawled over the ledges of the bench ludicrous caricatures of the parson, clerk, and the more prominent of the congregation. These boards were some years since in the possession of the Duke of Northumberland, by whom they were replaced. When his chalk was exhausted, Bewick resorted to a pin or a nail as a substitute. In consequence of this propensity to drawing, some liberal people,

of whom he says there were many in Newcastle, got him bound apprentice to a Mr. Bielby, an engraver on copper and brass. Of this period of his life Bewick says, in a memoir of his own life written by himself, but only lately published, "For some time I was employed in copying Copeland's Ornaments; and this was the only kind of drawing upon which I ever had a lesson given me from any one. I was never a pupil to any drawing-master, and had not even a lesson from William Bielby, or his brother Thomas, who, along with their other profession, were also drawing-masters. In the later years of my apprenticeship, my master kept me so fully employed that I never had any opportunity for such a purpose, at which I felt much grieved and disappointed. The first job I was put to do was blocking out the wood about the lines on the diagrams (which my master finished) for the 'Lady's Diary,' on which he was employed by Charles (afterwards the celebrated Dr.) Hutton; and etching sword-blades for William and Nicholas Oley, sword manufacturers, at Shortly Bridge. It was not long till the diagrams were wholly put into my hands to finish. After these, I was kept closely employed upon a variety of other jobs, for such was the industry of my master that he refused nothing, coarse or fine. He undertook everything, which he did in the best way he could. He fitted up and tempered his own tools, and adapted them to every purpose; and taught me to do the same. This readiness brought him in an overflow of work; and the workplace was filled with the coarsest kinds of steel stamps, pipe moulds, bottle moulds, brass-clock faces, door-plates, coffin-plates, bookbinders' letters and stamps, steel, silver, and gold

seals, mourning rings, etc. He also undertook the engraving of arms, crests, and cyphers on silver, and every kind of job from the silversmiths; also engraving bills of exchange, bank notes, invoices, account-heads, and cards. These last he executed as well as did most of the engravers of the time; but what he excelled in was ornamental silver engraving."

"During his apprenticeship," says a friend, "Bewick walked most Sundays to Ovingham (ten miles) to see his parents, and, if the Tyne was low, crossed it on stilts, but if high-flowing, hallooed across to inquire their health, and returned. This youthful genius was bound down by his master to cut clock-faces and door-knockers, of which, long after he had attained to fame, several were to be seen in the streets of Newcastle. After his apprenticeship, Bewick came to London, and worked a short time for a person in Hatton Garden; but he disliked London, and longed for his native home, to whose braes and banks he joyously returned. Here he was occupied in cutting figures and ornaments for books." All this was a curious mechanical training for a youth of artistic genius, though not unlike that which Hogarth received. Bewick thus continues his quaint and interesting narrative:—"While we were going on in this way, we were occasionally applied to by printers to execute woodcuts for them. In this branch my master was very defective. What he did was wretched. He did not like such jobs. On this account they were given to me; and the opportunity this afforded of drawing the designs on the wood was highly gratifying to me. It happened that one of these, a cut of the 'George and Dragon' for a bar-bill, attracted so much notice, and had

so many praises bestowed upon it, that this kind of work greatly increased. Orders were received for cuts for children's books; chiefly for Thomas Saint, printer, Newcastle, and successor of John White, who had rendered himself famous for his numerous publications of histories and old ballads." Meanwhile, he never omitted visiting itinerant caravans of animals which happened to stay in the towns, and from the living looks and attitudes of these he made spirited drawings. "My time," he adds, "now became greatly taken up with designing and cutting a set of wood-blocks for the 'Story Teller,' 'Gay's Fables,' and 'Select Fables;' together with cuts of a similar kind for printers. Some of the fable cuts were thought so well of by my master, that he, in my name sent impressions of a few of them to be laid before the Society for the Encouragement of Arts; and I obtained a premium. This I received shortly after I was out of my apprenticeship, and it was left to my choice, whether I would have it in a gold medal or money (seven guineas). I preferred the latter; and I never in my life felt greater pleasure than in presenting it to my mother."

The chief of the engravings which obtained the notice of the Society of Arts was the "Old Hound" in the edition of "Gay's Fables" referred to. A glance at this picture will show to what a low state wood engraving had reached when a public society deemed it worthy of a reward. Yet even in this are traceable some lines and touches of the future master of the art.

The typographer, Bulmer, of the Shakespeare Press (a native of Newcastle), now employed John Bewick, in co-operation with his brother Thomas, to embellish a

splendid edition of Goldsmith's "Deserted Village," and Hermit, Parnell's Poems, and Somerville's "Chase." The designs and execution of these were so admirable and ingenious that it is stated that King George III. doubted their being worked on wood, and requested a sight of the blocks, at which he was equally delighted and astonished.

A personal friend of Bewick has left a pleasing sketch of the homely life and appearance of this remarkable man.

"The first time," says the friend referred to, "that I had a personal interview with my venerable friend was at Newcastle-upon-Tyne, on Wednesday, October 1, 1823, with my friend, Mr. J. E. Bowman. We had been told that he retired from his work-bench on evenings to the 'Blue Bell on the Side,' for the purpose of reading the news. To this place we repaired, and readily found ourselves in the presence of the great man. For my part, so warm was my enthusiasm, that I could have rushed into his arms, as into those of a parent or benefactor. He was sitting by the fire in a large elbow-chair, smoking. He received us most kindly, and in a very few minutes we felt as old friends. He appeared a large athletic man, then in his seventy-first year, with thick, bushy, black hair, retaining his sight so completely as to read aloud rapidly the smallest type of a newspaper. He was dressed in very plain brown clothes, but of good quality, with large flaps to his waistcoat, grey woollen stockings, and large buckles. In his under lip he had a prodigious large quid of tobacco, and he leaned on a very thick oaken cudgel, which, I afterwards earned, he cut in the woods of Hawthornden."

Bewick lived to see himself universally regarded as the father of this useful art in its late developments. After a long and happy retirement, surrounded by his family, he died in 1828, at the age of seventy-six.

CRIME AND THE TELEGRAPH.

No event in connection with the early history of the electric telegraph in this country was more striking to the popular mind, than the detection and arrest of the murderer Tawell through the instrumentality of the wires of Messrs. Cooke and Wheatstone, which had just been laid down from Paddington to Slough.

On New Year's day, 1845, a woman named Sarah Hart was found murdered in a cottage, at Salt Hill, near Eton, famous as the annual scene of the Eton Montem. Screams had been heard by a woman who lived in an adjoining cottage, and who going out into her garden with a lighted candle in her hand, could just discern a man, in the peculiar attire of the Society of Friends, hurriedly passing from the cottage, and who resembled a stranger who had been observed, from time to time, to visit at the cottage. Sarah Hart was found to be expiring, apparently from the effects of some powerful poison, and no account could be obtained from her of the causes of her condition; but a clergyman named Champneys, hearing that the supposed murderer had been seen to go in the direction of Slough, he immediately proceeded to the

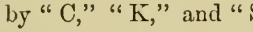
Slough station, where he was just in time to see a man in Quaker attire pass into a first-class carriage. Mr. Champneys communicated his suspicions to the station-clerk, who immediately transmitted to the Paddington terminus the following telegraphic message:—"A murder has just been committed at Salt Hill, and the suspected murderer was seen to take a first-class ticket for London by the train which left Slough at 7h. 42m. p.m. He is in the garb of a Quaker, with a brown great coat on, which reaches nearly down to his feet; he is in the last compartment of the second first-class carriage." After a short time the following reply was received from Paddington:—"The up-train has arrived, and a person answering, in every respect, the description given by the telegraph, came out of the compartment mentioned. I pointed the man out to Sergeant Williams. The man got into a New Road omnibus, and Sergeant Williams into the same."

From that moment the murderer's detection was certain. The officer, who had had time to attire himself in private clothes pending the arrival of the train, never lost sight of him for a moment; and there, while the murderer fancied himself far beyond reach of detection, sat a harmless-looking passenger in the same omnibus carefully, but stealthily, observing all his movements. On the omnibus arriving at the Bank, Tawell got out, crossed over to the statue of the Duke of Wellington, where he stopped for a short time, looking about, it is supposed, to see if any person was following him. He then proceeded to the Jerusalem Coffee-house; thence, over London Bridge, to the Leopard Coffee-house, in the Borough; then back again to

Cannon Street, in the City, to a lodging-house in Scott's Yard, where he was apprehended, with documents in his pocket that led to his being identified, and finally executed, for a murder peculiarly cruel and deliberate.

Tawell, however, had very nearly escaped through an unfortunate peculiarity of the telegraphic code of symbols with which the manipulators had not then become familiar. This was the fact, that in the telegraphic alphabet no separate signs or symbols were in use to represent "J," "Q," or "Z," each of these being represented by "C," "K," and "S." The transmitter of the message from Slough had to communicate that the fugitive was attired as a Quaker; this was, in fact, the only clue to his detection, though an admirable one when understood. But the clerk was embarrassed for want of a symbol for "Q;" the use of "K" for the purpose was difficult. After an interchange of the signals "repeat," "not understood," etc., by which valuable time was lost, the operator at Paddington finally guessed the word just in time for the arrival of the expected train.

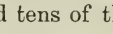
AN UNINTENDED INSECT TRAP.



The electric light which was lately used to illuminate the Place du Palais Royal, in Paris, was found to be subject to remarkable changes in its brilliancy, arising from a very singular and unexpected cause. Every

evening, and especially after a very warm day, clouds of insects collected around it, and each of them appeared to be drawn irresistibly towards the bright points of burning carbon; but the instant they touched it they were broiled to death. The numbers that crowded to it, however, were so enormous, that the light appeared at times to be almost extinguished by burning insects, and every morning the bodies of these unfortunate suicides were found heaped up at the bottom of the lantern in thousands and tens of thousands. An ingenious Frenchman having luckily discovered a new method of keeping insects out of lanterns, this cause of the discontinuance of electric light will, no doubt, very soon be put an end to.

THE WONDERS OF WELL-BORING.



The well of Grenelle has long been regarded with wonderment by visitors to Paris. Sunk to the depth of eighteen hundred feet through chalk, sand, and flint, and occupying eight years in process of construction, this well delivers from its bore of about seven inches only six hundred and sixty gallons a minute, at the surface of the ground. This wonderful Artesian well has, however, recently found a rival in the well at Passy (a suburb of Paris), concerning which M. Dumas, the distinguished chemist, has recently communicated a report to the French Academy of Sciences. The project of the well

originated in the shortened supply of water for domestic uses. An accomplished engineer proposed to undertake the work of boring a well of the average diameter of twenty inches, in the neighbourhood of Passy, which should deliver fourteen thousand cubic yards of water per day, at an altitude of ninety feet above the highest point in the Bois de Boulogne. Somewhere about the close of the year 1854 the work was resolved upon and commenced. Without encountering any obstacle of special importance, it was pushed forward unceasingly until March of the year 1857, when the bore had reached a depth of nearly seventeen hundred feet, and water was daily looked for.

But a difficulty here overtook the enterprise, which seemed almost insurmountable. The iron tubing which follows the bore burst at the depth of a hundred and sixty feet, under the pressure of the clay. Three years of unceasing activity were required to remedy the results of this accident, before the boring could be renewed. It was found necessary to sink a shaft beside the tubing to a depth of a hundred and seventy feet, of an average diameter of seven feet. The sides of this shaft were supported by iron tubing, which, although of more than half an inch in thickness, frequently snapped like glass. The labourers deserted the work, and refused to risk their lives in its prosecution. In this emergency, the engineers themselves volunteered to descend until confidence was restored. At the close of the year 1859 this supplemental labour was brought to an end; the point of the original breakage was reached; the *débris* was removed, a safer tubing supplied, and the boring pushed on without serious difficulty until, at the close of Sep-

tember last, the water burst forth, and the orifice has delivered since that date a volume of over twenty thousand cubic yards per day; this at a temperature of about 84° Fahrenheit, and sufficient for the ordinary supply of a population of half a million of people.

THE INTRODUCTION OF MAHOGANY.

It was only at the beginning of the last century that mahogany became known in Europe. At this period the brother of the celebrated Dr. Gibbons, commander of a vessel employed in the service of the East India Company, brought back, as he happened to have room for stowage, a quantity of the wood of this tree. He sent them to his brother, the Doctor, who at that time was employing an architect to build a house for him in Covent Garden; but the carpenters having found the strange wood too hard for their ordinary tools, they refused to work upon it. The wood then remained for some time forgotten in the Doctor's garden. A few years later it happened that a small box was made from a plank of this wood which was found in the garden. The cabinet-makers complained, as the carpenters had done, of its extreme hardness, and of the injury which it caused to their tools; but the Doctor advised them to get harder and sharper tools, and at length the box was finished.

Dr. Gibbons was so well satisfied with the beauty

of its appearance that he ordered a bureau to be made of the new material. The workman whom he employed was skilful and persevering, and he succeeded to perfection. Gibbons, delighted with his discovery, showed the work to his friends, and the eccentric Catherine, Duchess of Buckingham, admired it so much that she begged the Doctor to give her the wood necessary for making another. It was thus that mahogany was first introduced into England, where, coming into general use during the last century, it passed into the different countries of Europe.

PRIESTLY AND THE BREWERY.

Probably few persons who drink those effervescing waters which we so welcome in the heat of summer are aware that we owe their introduction to the philosopher Joseph Priestly, who has himself related the anecdote of the discovery of the principle on which they are produced. He tells us that it was towards the end of the month of June, 1767, that he left his residence at Warrington to establish himself at Leeds. The accident of his residence for the year of his stay in the latter town being contiguous to a brewery, first gave him the idea of making experiments with the fixed air constantly produced in the making of beer. But for this circumstance, he tells us, that he should probably never have turned his attention to the subject of the

different kinds of air and of their different properties; for when he began his experiments he knew very little of chemistry, and had no idea on the subject until a short time previously, when he attended a course of school lectures, delivered at the academy at Warrington, by Dr. Turner, of Liverpool. "I have often thought," adds Priestly, "that, upon the whole, this circumstance was no disadvantage to me, as, in the situation, I was led to devise an apparatus and processes of my own adapted to my peculiar views. Whereas, if I had been previously accustomed to the usual chemical processes, I should not have so easily thought of any other; and, without new modes of operation, I should hardly have discovered anything materially new."

One of the first operations of Priestly in this field was to place vessels filled with water over the spot where the fixed air issued at the surface of the vats holding beer in fermentation. After leaving them on the previous night, he generally found, on coming in the morning, that the water had become impregnated with a pleasant flavour; and the philosopher relates that it was with a singular satisfaction that he drank for the first time of this water, the first of its kind ever tasted. Many of Priestly's friends could remember coming to see him at this period, when he was accustomed to regale them with a glass of this artificial Pyrmont water made in their presence.

It was an accident which subsequently led him to put in practice a method for producing the same effect with fixed air set free from lime and other calcareous substances. He happened to be dining with the Duke of Northumberland in the spring of the year 1772,

when the latter showed to Priestly a bottle of water distilled by Dr. Irving for the use of the navy. It was perfectly sweet, but it had the freshness and flavour of pure spring water. The idea immediately struck him that he could easily cure this flatness by the aid of one of his vessels, and thus furnish an easy means for preventing scurvy in the navy, an object in which he succeeded.

A STRANGE SUBSTANCE.

In the years 1786 and 1787, some workmen engaged in the Cemetery of the Innocents in Paris, in removing human bones and other remains to the catacombs beneath the city, came upon a number of dead bodies which presented a remarkable appearance. Those particularly which had been interred about fifteen years before in a common grave, the biers of which, to the number of fifteen hundred, had been heaped one upon the other, had become transformed into a white and soapy substance such as had never been remarked before. The bodies had become compressed under the weight of each other, and, although they had generally preserved their original shape, there was found deposited around the bones of a great number a strange substance of a greyish white, and somewhat soft and flexible. The chemist Fourcroy presented to the Academy of Sciences in 1789 a report upon this phenomenon, in which he

stated that the fatty substance in question was an ammoniacal soap containing phosphate of chalk; that, like the spermaceti, it took, in spontaneously cooling, a crystallized and foliated structure; and that, like wax, by rapid cooling, it became granulated. He called this new substance, in consequence, Adipocire. He supposed it to be a natural result of the slow decomposition of all animal matter, with the exception of the bones, the nails, and the hair of the body.

Though lost sight of for many years, this discovery subsequently became of great importance in the useful arts. In 1812 it was examined again by M. Chevreul, and this eminent chemist found that it contained certain acid substances called margarin and olein, common to all oils and fatty matters, and that it had no connection with spermaceti, as supposed by M. Fourcroy. According to Gay-Lussac and Chevreul, adipocire proceeds entirely from the fatty matter pre-existing in the body, and not in any alteration of the flesh, the tendons, or the cartilage; a supposition which had occasioned a number of costly and fruitless experiments for converting on a grand scale the bodies of horned animals into adipocire, so as to render them fit for the manufacture of candles and soap by merely exposing them to moist air. The uses to which this substance has since been employed in the arts are well known.

THE INVENTOR OF LITHOGRAPHY.

In the year 1817, Alois Senefelder, a native of Munich, published to the world for the first time a practical work on the new art of Lithography, of which he was the inventor, and to this remarkable book he prefixed a modest but extremely interesting narrative of his own life, and of the circumstances which led him to his important discovery.

Senefelder's father was an actor at the Royal Theatre at Munich, and the son was from childhood anxious to follow his father's profession. Sent to the University of Ingolstadt to study the law, he wrote a little comedy in the year 1789, which was so well received by his friends that he sent it to the press, and had the good fortune to clear fifty florins, after defraying the expenses of the printing. Soon after this, Senefelder lost his father; and his reduced circumstances compelled him to discontinue his studies, and launch upon the world at once as a strolling player. In this pursuit having for two years suffered a great deal of misery and disappointment, his enthusiasm for the stage had considerably cooled down, and he resolved to forsake this unpromising profession, and to try his fortune as an author.

Even in this plan, however, he was not very successful. The first attempt he made to publish another of his dramatic productions entirely failed, as the piece could not be got ready for the Easter book-fair at Leipsig. It scarcely produced enough to pay the expenses incurred by the unfortunate author, who was reduced to despair; but

the circumstance led to consequences of far more importance to the world than the publication of his play. In order to accelerate the production of the work, he had passed several days in the printing-office, and had made himself acquainted with many of the details of the printer's art. He thought it so easy, that he desired nothing more than to possess a small printing-press, and thus to be the composer, printer, and publisher of his own productions. "Had I then," says Senefelder, "possessed sufficient means to gratify this wish, I should never perhaps have been the inventor of the lithographic art; but as this was not the case, I was obliged to have recourse to other projects." After persevering efforts to make wooden types, and to cast stereotype plates, he took to practising the writing of print characters backwards on a copper plate covered with etching ground, in order afterwards to bite in the writing with acids, and take impressions from it. The greatest difficulty he met with in this labour was to correct the mistakes he occasionally made in writing; for he was so completely dependent on his own ingenuity as to be utterly ignorant of the common "covering varnish" of the engravers. After some experiments, he invented for this purpose a composition of wax, common soap, and lampblack, dissolved in rain-water, which answered the purpose required. The cost of copper-plates was his next difficulty, and his attention having been attracted by a fine piece of Kellheim stone, which he had purchased for the purpose of grinding his colours, it occurred to him that by covering this plate with his composition ink, he could use it as well as the copper or tin plates; and in this, after numerous experiments in polishing the surface of

the stones, which he minutely describes, he ultimately succeeded. But this, as all who are acquainted with the art are aware, had no connection with lithography, to the discovery of which the ingenious artist was led as it were blindfold. "As I got on," he observes, "it is more than probable that if my circumstances had improved, I should have returned to copper plates, as the thickness and size of the stones rendered their use by no means more convenient;" but a trifling accident brought him suddenly about this time to the discovery of a new art.

"I had just, he continues, "succeeded in my little laboratory in polishing a stone plate, which I intended to cover with etching ground, in order to continue my exercises in writing backwards, when my mother entered the room and desired me to write her a bill for the washerwoman, who was waiting for the linen. I happened not to have even the smallest slip of paper at hand, as my little stock of paper had been entirely exhausted by taking proof impressions from the stones; nor was there even a drop of ink in the inkstand. As the matter would not admit of delay, and we had nobody in the house to send for a supply of the deficient materials, I resolved to write the list with my ink prepared with wax, soap, and lampblack on the stone which I had just polished, and from which I could copy it at leisure." It was natural that the etcher should next have thought of applying aquafortis and water by way of experiment to the stone, in the hope that it would leave the writing in sufficient relief for printing from. Once thought of the experiment was easy. It succeeded, and a kind of lithographic drawing and writing was thus discovered.

The secret was one of great value; but Senefelder was still too poor to take advantage of it. Knowing no better means of obtaining a sum of money for the furtherance of his projects, he actually enlisted as a private soldier as a substitute for an acquaintance, who promised him a sum of two hundred florins; but when he arrived with other recruits at Ingolstadt, it was found that he was not a native of Bavaria, and therefore could not serve. At Ingolstadt he found a musical publisher who consented to allow him to turn the new art to account in printing music for him. This publisher, whose name was Glaisman, issued several works printed from lithography, and the process was so favourably received that the elector sent the printers a present of one hundred florins, and promised them a patent for the practice of their art in his dominions.

It might be supposed that Senefelder's troubles were now at an end; but disappointments and annoyances still beset him. A new and more elaborate press, constructed by him at the cost of all his savings, produced to his great chagrin only blotched and dirty impressions. "It is," he says, "and will be as long as I live, perfectly incomprehensible to me how I could have been so perplexed as not to discover immediately the cause of this failure; but it cost me two years of great trouble and anxiety." The cause when discovered proved to be a most trifling circumstance. With great patience and perseverance he then set to work to increase the pressure by means of a lever and a stone of three hundred pounds weight, which descended from a height of ten feet, producing a pressure of more than fifty tons on the stone; but he was deterred from further improving the press, as on

one occasion he had a very narrow escape from being killed by the immense stone which by an accident fell from its height. "The consideration that the same accident might occur in future to the printers," says the good-hearted Senefelder, "rendered the whole press odious to me, and I was therefore easily induced to pursue another plan."

Meanwhile valuable time was lost. The period at which they had engaged to deliver copies of a great work had expired, and Senefelder and his partner were unable to perform their contract. Their new art almost lost its credit and reputation, and even the privilege which the Elector had promised was refused them, so that during the lifetime of Charles Theodore they were never able to obtain it. Their little gains were entirely consumed; debts were incurred, and the ridicule of those whom the success of their first trials had rendered jealous, was after years all the fruit they had obtained from their laborious endeavours to promote a new art. Better times, however, came at last. Numerous improvements both in the practical art of drawing and writing on stone, and in the machinery for printing, were gradually introduced by the indefatigable Senefelder, who had the good fortune to obtain patents for his inventions in Bavaria and Austria. Employment flowed in upon him; and lucrative undertakings were shared by himself and his partner. In England the art was introduced early in the present century by a Mr. André, and subsequently revived by Mr. Ackermann, of the Strand. In Berlin, in St. Petersburgh, and even in Philadelphia in the United States, lithography became about the same time successfully practised. "God

grant," says Senefelder, in the conclusion of his simple narrative, "that lithography may soon spread all over the world; that it may prove useful to mankind, and contribute to their improvement, and that it may never be abused to any dishonourable or wicked purpose, and I shall then never cease to bless the hour in which I invented it."

This ingenious man, who gave birth to a branch of industry which he lived to see employing thousands of persons, and whose discovery gave a high value to the famous Munich stone, now an important article of export from Bavaria, died in 1834, at Munich, where he had superintended to the end of his days the first lithographic establishment set up in that country.

THE FIRST VICTIM OF THE LOCOMOTIVE.



Those who can remember the introduction of the railway system into this country cannot yet have forgotten the gloom cast over the public mind by the shocking accident which marked the inauguration of the Liverpool and Manchester Railway—the first line constructed in England—an accident by which one of the most remarkable statesmen, and one of the soundest political economists of that time, was suddenly deprived of life in the presence of the entire British Cabinet, his brother ministers. We refer to the death of Mr. Huskisson, which took place on the 15th of September, 1829. It was on that day that it was determined to open the new line, and the excite-

ment in the public mind was at its highest point. The sanguine had been daring enough to predict the day when passengers should be carried at not less than twenty miles an hour through tunnels and cuttings, and over embankments and viaducts, spanning busy high roads and murky housetops; while old adherents of the coaching interest shook their heads, and prophesied that no good would come of so daring an attempt at innovation upon the ways of our forefathers. In the town of Liverpool a general holiday was observed, and all were in expectation of the brilliant assemblage who had been invited to the ceremony. At half-past nine in the morning eight locomotives were drawn up at the entrance of the tunnel in Liverpool. The Duke of Wellington arrived at ten, and was received with enthusiasm by the crowd, which was immense. At the moment when the magnificent carriage prepared for the Duke issued from the tunnel a military band played the air entitled "See the conquering hero comes," and the multitude burst forth in joyous huzzas. The *cortége* left the town at twenty minutes to eleven drawn by the eight locomotives, which, as the venerable progenitors of all passenger engines, deserve honourable mention in the history of that day. There were the Northumbrian drawing the Directors and the guests of distinction—the Phœnix, the Star of the North, the Rocket, the Dart, the Comet, the Arrow, and the Meteor, each of which was distinguished by a flag of a different colour. On issuing from the tunnel, the Northumbrian took the road to the right with its three carriages, of which the first carried the musicians, the second the Duke of Wellington, Sir Robert Peel, and the remainder of the ministers and

other distinguished persons, and the third the directors of the companies. The seven other locomotives then took the way to the left, each drawing four or five carriages, the entire *cortége* being composed of 772 persons.

The trains moved slowly, alternately accelerating or retarding their progress to permit the party to examine the more remarkable portions of the work. At length they came to a stand at the Parkside Station, to enable the engines to take a fresh supply of water. The joyous and delighted company were far indeed from suspecting the calamity which was about to result from this stoppage. Before leaving Liverpool all had been cautioned not to descend from the carriages on to the line, a precaution which was unfortunately not so well understood at that time as it would be in these days of universal railway travelling. The caution had even been inserted in the printed programme of the day's festivities, a copy of which had been handed to every guest. Notwithstanding this, however, Mr. Huskisson, who then filled the office of Home Secretary in the British Cabinet, accompanied by Mr. William Holmes, a Member of Parliament, and some others of the travellers, ventured to get out of their carriage at the Parkside Station, the two former with the intention of going to exchange some words with the Duke of Wellington, whose carriage occupied the right line of rails. The scene was observed with interest by the company, as a coolness had been known to exist between the Duke and Mr. Huskisson, and the cordiality with which the former greeted him was felt to be in harmony with the good auspices of that day. Mr. Huskisson and the Duke were in the act of

warmly shaking hands at the window of the carriage, when, to the alarm of the more cautious of those who were looking on, the Rocket was suddenly observed to continue its progress on the parallel lines. Those who had descended now fled to regain their places. A general cry of "Get in! get in!" was heard. Some were nimble enough to obey this warning, climbing into the carriages how they could. Others took shelter behind the carriage of the Duke. But there was one, a man already sixty years of age, whose activity was unhappily not so great. This was the unfortunate Mr. Huskisson. For a moment he stood undecided. His first idea appeared to be to cross the line before the Rocket, but the height of the embankment at this point deterred him. Mr. Holmes, who was in the same position, decided more promptly, and pressed his body as closely as possible against the side of the carriage of the Duke. The space between the two ways was only four feet, the projection of the Duke's carriage was about two feet, and that of the terrible Rocket six inches only, so that there remained a breadth of eighteen inches, just sufficient to make it possible to escape. Mr. Holmes, seeing the unfortunate indecision of the minister, cried to him, "In Heaven's name, Mr. Huskisson, do not stir!" but unfortunately the latter had pulled open the door of the carriage, and was about to endeavour to pass round it, when the Rocket struck the door. Mr. Huskisson was struck down, and the engine, which was driven by Mr. Locke, afterwards the celebrated engineer, passed over Mr. Huskisson's left leg, smashing the bone.

The Earl of Wilton, Mr. Holmes, and others rushed

to the spot and lifted the unfortunate minister, who exclaimed, "I am a dead man! May God have mercy on my soul!" Mr. Huskisson died the same night at Eccles, where he was removed immediately after the accident by the Northumbrian engine, driven by George Stephenson himself, who conveyed the wounded man the fifteen miles in twenty-five minutes, or at the rate of thirty-six miles an hour, a fact which burst upon the public as by far the most marvellous achievement yet heard of in connection with steam.

Assuredly, if there were any truth in the popular belief in evil omens, men might have taken a gloomy view of the prospects of railway travelling. A consultation was held, at which the Duke, who never afterwards lost his antipathy to railways, strongly urged that the company should return to Liverpool. But the proposition was finally negatived, and it was resolved to proceed with the ceremony for fear of causing alarm and prejudice among the crowds who had flocked from all parts to witness the scene. Mr. Huskisson had been conveyed to the vicarage-house at Eccles, while another of the engines, despatched to Manchester, had brought back the best medical aid which could be obtained. But his recovery was soon perceived to be hopeless. His sufferings were terrible, and amputation of the limb was pronounced impracticable. In the evening of that day the Sacrament was administered to the dying man and to Mrs. Huskisson, when the former said, "The country has had from me all that I was able to give. The short time longer which I hoped to live I do not regret for myself." But he added, grasping the hand of his wife, and looking tenderly upward

into her face, "Only for you. Only for those who are dear to me, and whom I leave behind." His sufferings terminated on the following day.

It is remarkable that the engine which was the cause of this sad ending to the first day of British railroad travelling was that famous "Rocket," which must always be remembered with the name of the illustrious George Stephenson. The work of George, and of his scarcely less famous son Robert, it was the first really successful locomotive, having recently won the prize at the celebrated locomotive trial at Rainhill, where the engines of the other competitors were scarcely worthy of the name of locomotives. The fate of the old Rocket is curious. In 1837, having been superseded by the improved engines afterwards constructed, it was sold, and for five or six years was doomed to the degrading drudgery of drawing coals from a colliery in the North of England to a neighbouring town. Even here, though proved on one occasion to be capable of a speed of sixty miles an hour, it was again doomed to be beaten from the field. The proud victor of Rainhill, which weighed only four tons, was compelled to retire before the more powerful machines weighing three times that weight, which the example of the Rocket itself had taught men to construct. The Rocket was then laid up and forgotten in a yard at Kirkhouse, near Carlisle, until very recently it was fortunately secured for the Patent Museum at South Kensington, where, side by side with its rude progenitor "Puffing Billy," of the Wylam Colliery, this interesting relic has at length found an honourable asylum.

THE LABOURS OF NIEPCE AND DAGUERRE.

About the period when Watt, Wedgwood, and the illustrious Davy were prosecuting their fruitless researches into the effects of light, in creating images on prepared plates, there lived at Chalons, on the borders of the Saone, in central France, two brothers named Niepce. The elder, Joseph, was the proprietor of a small estate, and on the fruits of this property he contrived to live, and to amuse himself with experiments in philosophy. Joseph Niepce was a man of little scientific education, and, probably, if he had been fully aware of the difficulties which had been encountered by previous inquirers in the particular field which he selected, he would have shrunk disheartened from many of his experiments. Joseph, however, had a brother who, possessing more knowledge, and being equally blessed with the leisure which a small income, combined with remarkably simple habits, secured him, he quickly imbibed kindred tastes, and the two brothers soon devoted themselves ardently to these studies. The poor peasants of the neighbourhood of Chalons often looked in at the door of the mechanical workshop in the little farm-house where these two ingenious agriculturists were engaged in constructing strange machines, and experimenting on new substances useful in the arts. Here they constructed as early as 1806 a new locomotive machine, in which rapidly heated air was substituted for steam. This curious machine attracted the attention of the *savant* Carnot, who made a report upon the subject to the

Institute. The cultivation of a plant called pastel, in which they sometimes engaged, suggested to them the preparation of a vegetable dye from that substance for superseding indigo, a question of great importance at that period, when the foreign war deprived the French of colonial productions. Several other ingenious discoveries were made by these two farmers ; when at length an invention which must always rank among the greatest of our acquisitions in the fine arts, completely altered the direction of the labours of Joseph Niepce.

The invention of lithography by Senefelder had then been lately adopted in France, and the thoughts of the artistic world were greatly occupied with that curious method. Quarries fitted to yield lithographic stones were eagerly sought for in all parts. The busy mind of Joseph Niepce was attracted by the subject. He made a number of attempts at reproduction on some stones of a delicate grain which he found collected to be broken up upon the high road to Lyons. These attempts having failed, the idea struck him to substitute plates of polished metal for stone. Accordingly he tried to reproduce some sketches executed upon a metallic plate with lithographic chalk. One day, when wearied with these labours in his little workshop, a broad bar of sunlight streaming through the open doorway fell upon his face, and produced a reflection of his own image on the polished plate which he was poring over. It was thus that the idea entered his mind that if he could imprint such images by the mere action of the rays of sunlight, he would have secured an invention of far greater importance than even the ingenious art of the Munich actor.

By what series of mysterious transitions Niepce,

from simple attempts in typography, was led to approach what was, perhaps, the most difficult problem in physical science of his time, is not known. He had no knowledge of the laborious attempts of Watt, Wedgwood, or Davy, or of the despair with which others scarcely less illustrious had abandoned this object after a fruitless pursuit; but his uninformed state of mind was probably an advantage, in emboldening him to undertake the task which cost him so many years of persevering research, that death surprised him before he had the satisfaction of gaining the legitimate recompence of his labours.

From that hour Niepce was wholly absorbed in the idea of imprinting images by sunlight. Amid the great wars which devastated his country, he took no heed of anything but his solitary workshop. An eloquent French writer tells us that at the time when his countrymen were solely occupied with the question, "Will to-morrow's sun shine upon the triumph or the enslavement of our country?" Niepce's only question was, "Will to-morrow's sun produce any effect upon the new combination which I discovered yesterday?" It was in the early part of the year 1814 that success first began to dawn upon his unwearied efforts. Niepce knew that a certain black resinous substance, known in the arts as bitumen of Judea, on being exposed to the sun rapidly became white. He knew, also, a fact which all chemists are aware of, namely, that the greater part of preparations of silver, naturally colourless, blacken by the action of the sun's rays. Acting upon these facts, he attempted in a singular way to reproduce engravings. Having varnished the reverse side of a print in order to render

it transparent, he placed it immediately upon a leaf of metal coated with the bitumen. The darker portions of the picture obstructed the rays of light, while those which were transparent, or which had not been touched by the graver of the artist, allowed them to pass freely. Thus, the luminous rays, penetrating the transparent portions, turned the bitumen spread upon the metal plate a white colour; and thus he succeeded in producing a faithful reproduction of the design, in which the lights and shadows preserved their natural position. Then, plunging the leaf of metal into a preparation of essence of lavender, he found, to his delight, the portions of the bitumen which had not been affected by the light were dissolved, and the image was thus disclosed, protected from the ulterior action of the rays.

This kind of copying of engraving, however, was only an object of secondary interest. The grand problem was, how to fix the beautiful images of the camera obscura; and in this Niepce finally succeeded in the year 1824. His chief agent was still the bitumen spread upon a copper plate silvered over, a troublesome and tedious process, the bitumen requiring a very long time to receive impressions. Not less than ten hours, indeed, were required to produce a picture in this way; and during this time the sun frequently displaced the lights and shadows before the image was completely taken. Pictures so produced by Niepce at this early period still exist, and are said to be far from imperfect. In fact, though photography had still great steps to take, the art which its inventor called at this time Heliography was in its principle at least discovered, and its future progress fully assured.

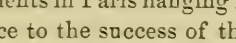
It was at this period, when Niepce had just obtained a successful result from his long and solitary labours, that there resided in Paris a man whose peculiar knowledge and whose ordinary occupations had led him to engage in similar researches. This was Daguerre. As a clever painter he had long been known among artists; but the public knew him chiefly as the inventor of the diorama, that kind of scenic exhibition which has since become so popular. Several of these dioramas of Daguerre had been exhibited in Paris with great success; and the special researches which he had thus been compelled to make into the effect of light and shade had naturally suggested to him the idea of endeavouring to fix the beautiful images of the camera obscura. Notwithstanding his persevering experiments, however, it is not proved that Daguerre had hitherto made any discovery of importance; when he suddenly learnt that in an obscure country village, a man scarcely known to science had resolved this difficult problem. Daguerre instantly sought an interview with Niepce, and after some distrust on the part of the country gentleman had been dispelled, a sort of inventing partnership was established between them. The association proved a fortunate one, at least for the interests of science. As soon as he was initiated into the secret of Niepce's discovery, the ingenious Daguerre set himself diligently to improve it. He quickly substituted for the bituminous coating of the original inventor a resin obtained by distilling essence of lavender. Instead of washing the plate in the essence he exposed it to the action of a vapour derived from it, from which he obtained results which showed progress.

The turning point in the history of the discovery of photography was now at hand. All the improvements on Niepce's original idea, which had hitherto been obtained, only diminished very slightly the tedious character of the process. Seven or eight hours were still necessary to obtain an impression. A still more serious inconvenience was the fact, that at the end of a certain time the image became partially effaced. A fortunate accident at length turned the inquiries in the right direction. Before his association with Daguerre, Niepce had endeavoured to give strength to his impressions by deepening the shades with sulphureous fumes and vapours of iodine. It happened one day that a spoon, left by accident on an iodized silver plate, had left a mark under the influence of light. The indication was not lost. For the resinous substances the inventors quickly substituted iodine, which gives to the silvered plates an exquisite sensibility to the light. Thus were gained the first great steps towards the solution of the problem which had cost twenty years of research. But the first inventor was not destined to see the triumphant accomplishment of those hopes which so long sustained him in his solitary labours, and which since his singular scientific partnership had seemed so near. Niepce died at Chalons on the 5th of July, 1833, at the age of sixty-three. Poor and unknown, "the author of the most remarkable discovery of our age (says his French biographer) passed away without glory, forgotten by his fellow citizens, with the bitter thought present in his dying hours of having consumed twenty years of his laborious career, dissipated his patrimony, and compromised the future of his family in the pursuit of an idea."

Left alone, Daguerre continued his researches with ardour. It was then that he made his great discovery of the influence of the vapour of mercury in bringing out the photographic image. The discoveries of Niepce and Daguerre were for the first time made known by the public announcement of Arago at the Academy of Sciences, on the 7th of January, 1839. The news created an extraordinary impression in the scientific world not only of France, but of all Europe. The name of Daguerre immediately acquired an immense celebrity; that of poor Joseph Niepce was for a time almost forgotten; but later writers have done justice to his merits, while some of the fruits of his success were fortunately secured to his family. On the 15th of June, 1839, only six months after the new inventor had been made known, the French Government presented to the Chamber of Deputies a law for according a national recompense to the inventor of photography. A pension of 6000 francs per annum was granted to Daguerre, while the son of Niepce received a pension of 4000 francs. About a month later M. Arago made a public communication of the secret of the process before the Academy. The occasion is a memorable one in the history of that body. On the seats reserved for the public all the eminent men and women in science, letters, and art were assembled. The enthusiasm of the meeting reached its highest point, when Daguerre hurriedly appeared standing beside the great *savant*, to whom he had relinquished the task of telling the story of the labours of himself and his fellow-inventor. "The next day," says a French writer, "the shops of the opticians in Paris were besieged. It was impossible to procure a

sufficient number of cameras to satisfy the demands of enthusiastic amateurs. People watched with regret the sun going down in the horizon, and the failure of that light which was the first necessity in their experiments. At early dawn they were seen at their windows, and with the first effective rays a crowd of eager experimenters were seen endeavouring with every kind of careful precaution to obtain upon a prepared plate the image of an opposite window and the perspective of a population of chimneys—often with no other result than the production of a confused, and blurred picture with a sky of the colour of ink, and with walls of a dismal shade;" but at the end of a few days successful pictures of nearly all the monuments in Paris hanging in the shop windows, testified at once to the success of the new discovery.

INGENUITY IN A NEW CHANNEL.



The engineer of the Thames Tunnel was remarkable for possessing very flexible joints and muscles, which were the cause of some ingenious but harmless practical jokes, in which he occasionally indulged. His daughter, Lady Hawes, among some interesting anecdotes communicated concerning her late father, and related by her to Mr. Beamish, gives one or two instances of this. On his first visit to Falmouth he sent for a tailor to take his measure for a coat. It was to be made in great haste, and the man promised to have it ready to be tried on the

following day. The promise was punctually fulfilled; but the coat did not fit. The right shoulder was discovered to be so much higher than the left, that to adapt it by any trifling alteration was impossible. With many apologies for not having observed the peculiarity, the man promised to correct his mistake without further loss of time. The same night the tailor returned, when to his astonishment he found that the peculiarity of formation instead of being in the right shoulder was in the left. He was utterly at a loss to account for his blunder; but it was impossible to doubt, that in his original perplexity he had altogether mistaken the side on which the supposed malformation existed. When in the climax of his bewilderment, Brunel with a laugh undeceived him, by explaining the hoax he had practised, and the practical joker having promised to pay for the extra trouble, the tailor joined heartily in applauding the joke.

On another occasion this peculiarity was exercised to better account. Brunel's known kindness to real distress brought upon him numerous attempts at imposture. It happened one day that he heard a woman asking for charity at his door, and almost forcing her way into the house, while piteously bemoaning an accident which had entirely deprived her of the use of her thumb, and consequently of her needle. It was apparently a case of severe dislocation, which had taken from her altogether the means of earning her livelihood. The manner of the woman, however, aroused Brunel's suspicion, and he asked to be allowed to examine the thumb attentively. Confident in a successful result, she unwound the bandages, and presented it. "Ah!" said the engi-

neer, after a slight scrutiny. "Very curious; almost as curious as *my* thumbs;" and to the astonishment of the woman he exhibited both his own thumbs, exactly in the condition in which she pretended her own to be. The cheat was discovered, and the impostor quitted the house without saying a word.

DISCOVERY OF PETROLEUM.

THE existence of petroleum—that mineral oil which has now become of such vast importance as an article of import in England—was well known in Europe long before any one in this portion of the world thought of turning it to useful purposes. In the East it had from an early period been largely consumed as a means of lighting. In Crawfurd's "Embassy to Ava," published nearly forty years since, appeared the following curious account of the complete success which had before that time attended the introduction of petroleum in a barbarous Asiatic country:—"Petroleum wells supply the whole Burman empire with oil for lamps, and also for smearing wood, to protect it against insects, and particularly the white ant. Its consumption for burning is stated to be universal, until its price reaches that of sesamum oil, the only other kind used for lamps. The wells, which occupy a space of about sixteen square miles, vary in depth from two hundred to two hundred and fifty feet; the shaft is square, not more than four feet each side, and is formed by sinking

a frame of wood. The oil, on coming up, is about the temperature of 90° Fahr. It is thrown into a large cistern, in the bottom of which are small apertures for the aqueous part to drain off, when the oil is left for some time to thicken. It is then put into large earthen jars, placed in rude carts drawn by oxen, and carried to the banks of the river, from whence it is sent by water carriage to every part of the empire. By the number and burden of the boats employed in this trade, and the number of voyages they are supposed to make in the course of a year, the exportation from the wells is estimated to amount to 17,568,000 vis, of twenty-six pounds and a half each. Thirty vis a year is reckoned to be the average consumption of a family of five persons and a half; and about two-thirds of the oil are supposed to be employed for burning." Notwithstanding this significant hint to Western enterprise, no one appears to have thought of using petroleum either in Europe or America till many years afterwards, when the discovery of the American oil wells suddenly placed a cheap and brilliant light within the reach of the poorest households in Europe and America.

The American oil region comprises parts of Lower and Upper Canada, Ohio, Pennsylvania, Kentucky, Virginia, Tennessee, Arkansas, Texas, New Mexico, and California, reaching from the 65th to the 128th degree of longitude west, and there are likewise outlying tracts. The oil is believed to be derived from silurian, devonian, and carboniferous rocks, and is conjectured to be a product of the chemical action by which ligneous matter is transmuted into coal. Dr. Gesner also suggests that in some cases animal matter may have been the source of

the hydro-carbon. To obtain the petroleum, borings are made through various strata to the depth of 150 to 500 feet. As a general rule, these borings pass through clay, with boulders, sandstones, and conglomerates, shale, bituminous shale, and then the oil, underlaid by the oil-bearing stratum of fire-clay, containing fragments of stigmaria and other coal-plants. As soon as the oil stratum is reached, there is an escape of carburetted hydrogen gas, often violent enough to blow the boring-rods into the air. When the oil comes it is ejected with much force, sometimes rising to the height of 100 feet. Some wells have at first given 4000 gallons in six hours. The average daily yield of mineral oils in the United States was estimated, two years since, at about 50,000 gallons. It is now probably half as much more. In Canada the petroleum is now largely used in making oil-gas.

Toronto, Niagara, Kingston, and other towns, are now lighted by gas derived from this oil, as are also railway carriages, and a great number of private houses. The gas is stated to be of great brilliancy. Six thousand cubic feet are obtained from a barrel of oil, and the apparatus for generating it is so simple that it can be managed by a servant with perfect facility. The fact that this abundant natural product has remained, until recently, practically unknown to mankind, is scarcely less remarkable than the rapidity with which its use has spread throughout the world.

THE LEGEND OF THE TELESCOPE.

Among the romantic episodes of the history of inventions there appears to be none better authenticated than that which ascribed the parentage of those magnificent instruments, by which Sir William Herschel, Lord Rosse, and other astronomers have explored the heavens, to the lucky idea of an uneducated man. The philosopher Descartes, in his "Treatise on Dioptrics," says, "To the disgrace of our men of science this invention, so admirable, is due entirely to a fortunate accident. It is now about thirty years since a man named James Metius, a man of no education, although he had a brother a professor of mathematics, took a pleasure in making small mirrors and burning glasses; and having, therefore, in his possession a number of glasses of different forms, the notion struck him of looking through two of them at the same time, the one being convex, the other concave; and he applied them so fortunately at the end of a wooden tube that the first telescope ever used in the world was at once discovered."

In addition to this curious account, an old chronicle published in Holland tells us that there were three brothers of the Metius family—Adrien, who was a professor at the University of Leyden; Anthony, a sailor; and Jacob, or James, who was a glass-cutter. This latter, says the chronicle, appeared to be of a somewhat dull and heavy intellect. He was so illiterate that he had

scarcely learned to read. He passed a life extremely retired, engrossed in his own peculiar amusements, and constantly preoccupied with some trifling invention, which he perseveringly pursued; or with some attempt at improving an old invention, chiefly in such mathematical instruments as his brother, the professor, had need of. Of his successes the most remarkable is his *tubus opticus*, that instrument which has enabled Galileo and Kepler to observe so many phenonema in the heavens. If it had been the fate of Metius to perfect it, or having perfected it, if he had deigned to show it to others, of what transcendent results he might have been the author it is easy to imagine. But this man, filled with a singular sort of pride, determined to be alone in his knowledge. He was so jealous of his discoveries that he would scarcely consent to exhibit his optical tube to Prince Maurice himself when the latter came to visit him in person. It was only after much persuasion that he consented at length to show it once only. His brother Anthony, the sailor, obtained this favour more often; but he refused it altogether to his brother Adrien, whose eye he dreaded as being able at once to detect the secret of the instrument. When he was dying, a priest named d'Alckmar, who attended him, endeavoured in vain to induce him to bequeath to the world an account of his mode of fabrication, or a sketch which could indicate the secret. But, happily, the secret was not lost. News of the discovery quickly spread through the learned world. Galileo, who was then at Venice, welcomed the intelligence with an ardent interest. He set himself to examine, by the aid of the theory of refractions, what could have been the combination of glasses which pro-

duced such marvellous results, and, aided by the hints he had obtained, he quickly succeeded. Having furnished the extremities of a tube with two glasses, one convex, the other concave, he turned it towards distant objects, and beheld them at once increased threefold in diameter. This first success encouraged him. He constructed an instrument which multiplied objects eight times, then a third which multiplied thirty times. It was with this instrument that Galileo commenced those series of astronomical discoveries which immortalized his name.

The legend of the discovery of the telescope has been differently told; some accounts giving the name of the Dutch inventor as Hans or John Lippershey, and describing him as a spectacle maker; but on the whole, the story as related by the great Descartes, and the anonymous chronicler, appears to be as well worthy of credit as any other version of this curious anecdote.

THE LABOURS OF SIR SAMUEL BENTHAM.

The curiously-constructed steam-ship, called the "Connector," which has recently been exhibited upon the river Thames, appears to be merely a revival of an idea of the late Sir Samuel Bentham, one of the most ingenious men of his time. Bentham travelled in Russia in 1781, on a tour of inspection into the manufactories and public works of that country, and, in April of that year, arrived

at Nijni Taghil, an iron-factory, the property of Count Demidoff, one hundred and forty versts north of Catherinaburg. To the intendant of those works he had brought a letter of introduction from the count, requesting that the traveller should be assisted in anything he might require; and Bentham took advantage of this to order the construction of a new kind of vehicle. He had travelled to this spot on sledges for the winter roads, and he now required a carriage on wheels for travelling in finer weather. At first it was proposed to make him one of the usual construction; but Bentham saw that such a vehicle would be of little utility in the wild region through which he proposed to pass; and he at once sketched out a novel kind of conveyance, which he considered would answer his purpose as a carriage on land, a boat on water, and a sledge on ice. This "amphibious carriage," as he called it, he not only planned, but worked on himself, the indolence and apathy of the Russian artificers rendering this necessary. He chalked on the floor the form and dimensions of the boat and the arrangement of its parts. When completed, he described the carriage in a letter as a vehicle hung as usual on springs, and, when intended for land service, suspended on wheels, but with a body of the novel shape of a boat. For service in the latter capacity, easy means were provided for detaching the carriage from the wheels if necessary; the latter being made so as to be capable of being taken to pieces and stowed away in the body, serving as ballast to what then became a boat. When it was completed, he set out in it for Perme, where it caused much amazement among the people. Being engaged to dine with the governor of the town,

Bentham, before the appointed hour, sailed up the river in his amphibious vehicle, in sight of the crowded windows of the Government House; and, shortly afterwards, it presented itself at the door in the shape of a carriage upon wheels, drawn by three horses. It is said that the amphibious carriage fully answered the purposes for which it was contrived—namely, rapid and certain means of conveyance in a country intersected with rivers, and ill provided with bridges. This invention he subsequently patented, and he afterwards extended the idea to army baggage-waggons, of which Prince Potemkin ordered a large number to be furnished to a regiment at Jassy. In gratitude to Count Demidoff, for the facilities which he had accorded him in constructing this carriage, the indefatigable Bentham invented for the use of the count's factory a wood-planing machine, which was also capable of being used for making mouldings by merely changing the cutting tool. The idea of the latter machine was suggested to his busy mind while his carriage was building, by the slowness and inaccuracy which he observed in the Russian carpenters.

It was his next invention—a sort of jointed vessel—which appears to have been almost identical with the more modern "Connector." This vessel was specially designed for the conveyance of the Empress Catherine down the Dnieper and its affluents, which were shallow and tortuous, and rendered unsafe by numerous sand-banks and sunken trees. It is described as having been in six links, drawing only six inches of water when laden, and with one hundred and twenty-four men at the oars on board; for, unfortunately, steam power, as

applied to the propelling of ships, was as yet unknown. The six links of this curious vessel were so connected together by a peculiar mechanism, that no interval was left between boat and boat greater than the diameter of a small iron pin; and by this contrivance the vessel could twist itself about as could a worm, for which reason Bentham gave it the name of the "Vermicular." The rowers were placed in the first two and part of the third of the foremost links, seated in such a manner that the stroke of no man could interfere with that of another. The other links were devoted to dining-room, drawing-room, and sleeping chambers for the Empress and her attendants. When the third, fourth, and fifth links were taken out, the remaining three formed a princely rowing-boat. Unfortunately, after completing this vessel for the special service of the Empress on a journey, Bentham arrived two hours too late with it at Kremenchuk, where he found that the Empress, tired of water travelling, had quitted her boats for a land journey. But the inventor navigated the river with the vessel for many days, having aboard the English and French ambassadors, the Count de Ségur, and the Emperor Joseph II.

The news of these strange contrivances of the young Englishman spread rapidly among the ignorant peasants, who regarded him with a sort of superstitious awe; but perhaps the amphibious carriage was the most successful in exciting their astonishment. While travelling in this strange vehicle, drawn by horses, Bentham rarely stopped on coming to broad or even rapid rivers; but ordered the peasant driver, who soon obtained confidence in his master's devices, to continue his course. On such occasions, the peasants of

his train gave a wondering glance at the party, then one of confidence in the superior knowledge of their temporary master, crossed themselves devoutly, drove down the bank, and onwards across the stream. The horses swam, the boat-built carriage floated, its inmates guided it, and on the opposite bank the land journey was resumed, all being safe and dry, while the peasant again crossed himself, with a *slava Boghi!* or "Thank God!"

Probably few heroes of romance have been represented as taking part in more singular scenes than might be gathered from the life of this eccentric man of genius. He may be said to have been an inventor and discoverer from his cradle. The youngest son of Jeremiah Bentham, and brother of Jeremy, the great moral writer, he was placed, when very young, at a private academy, from whence, at the age of six, he was sent to Westminster school. His father occupied a house in Queen's Square Place, in the stable-yard of which were spacious workshops, let to a carpenter. Here Samuel used to spend all his leisure time, and soon acquired considerable skill in handling tools; for, when only thirteen years old, he had managed to construct, with his own hands, a carriage for his young friend and playmate, Miss Cordelia Knight, whose autobiography has lately been published. At the age of fourteen he exhibited so strong a taste for naval matters that his father yielded to his wishes, and bound him apprentice to the master shipwright of Woolwich Dockyard. At that period, the superior officers of a royal dockyard were exempted from keeping their apprentices at hard labour, so that time might be allowed for general instruction. Samuel, however, soon perceived that practical manipulation was no less essential

than theoretical knowledge; and used, therefore, to work at the dock side till breakfast time, and devote the rest of the day to scientific acquirements. In time, Samuel and his master were removed from Woolwich to Chatham Dockyard, by which the former was enabled to obtain a practical knowledge of the behaviour of vessels at sea; for he was often permitted to sail in the British Channel, and sometimes extended his voyage further. About this period his brother, Jeremy Bentham, had returned from college, and used to instil into him many of the first ideas of political economy. On these occasions Samuel would take advantage of the Saturday afternoons to walk from Chatham to his brother's chambers in Lincoln's Inn. At the end of his seven years' apprenticeship, Samuel spent another year in the other royal dockyards, and at the Naval College at Portsmouth. He then went to sea as Captain Macbridge's guest, whose ship was one of Lord Keppel's fleet; and, on this occasion, he suggested sundry improvements in the apparatus of a ship, which were executed in Portsmouth Dockyard. In consequence of the abilities manifested by Bentham, many advantageous appointments were offered to him. These were, however, refused; and, in 1780, he embarked for the Continent, in order to obtain greater experience in the different practices in the art of naval construction.*

On his arrival in Russia, the Government of that country were not long in discovering the remarkable talents of their visitor, and young Bentham soon obtained from the Empress various employments. She determined to fix him for a time at St. Petersburgh,

* Papers and Practical Illustrations of Public Works.

and for that purpose appointed him a Conseiller de la Cour, with the rank of Lieutenant-Colonel. She also gave him in charge the works of the great Fontanha Canal, in the course of executing which the young Englishman invented a new pile-driving machine, such as he said, would put an end to the "habitual skulking" of the labourers, and by which, at the same time, the whole weight of the men would act beneficially instead of only employing their muscular force. The machine was a kind of ladder which yielded on every step that the men took on the same principle as the walking wheel; but his contrivance was much less cumbersome than the wheel, and therefore more easily moved from place to place as the work advanced.

Bentham was next sent to the Crimea on matters of far greater importance; but his observant mind was still busy on an infinite variety of things. He found time to make a collection of minerals from parts of Russia then altogether unknown to England, and forwarded to St. Petersburgh, for transmission to this country; three or four thousand pounds' weight of chosen specimens collected in the course of excursions of fourteen or fifteen hundred miles on horseback. Stopping one day at great salt mines, from which the Russian Government derived a large revenue, he examined the operations carried on in raising the salt water, and for crystallizing the salt from it, and did not leave until he had invented a number of important improvements. He showed the Russian workmen how to confine the fire heat to the boilers instead of losing much of it as they had been doing, and how to employ the heat of the steam for warming a supply of the solution. An entirely novel double

sucking-pump for raising the brine, which he also devised, was at once adopted and found to effect an enormous saving. He also suggested to the country people the introduction of potatoes, the making of hemp and linseed oils, so that, besides the profit these articles would afford to them, a still more considerable one would be obtained by fattening cattle with the oil cakes.

The great disorder which he observed on visiting the Prince Potemkin's factories at Cricheff induced him to offer his services, in a letter, to the Prince, in which he confidently declared his ability to raise the factories to a high degree of perfection. The offer was accepted, and the Prince's confidence was so great that he declared him at liberty to build any kind of ships, vessels, or boats, whether for war, trade, or pleasure. So little was Bentham restricted in carrying out his favourite schemes, that having one day troubled the Prince about some alterations in a frigate he proposed building, to make a present of it to the Empress, the Prince ended the discussion by telling Bentham that as to the new ship, and the number of its masts and guns, he "might put in it twenty masts and one gun if he thought fit." Bentham now assumed the chief control of a rope-walk where all the cordage was made for Cherson; a sail-cloth manufactory; a distillery of spirit from corn, to which was annexed a malt-house and a brewery; a tannery and leather manufactory; two glass houses, a pottery for making crucibles; and an establishment of blacksmiths and coppersmiths for making and repairing the tools and utensils required in the several fabrics. Meanwhile, like his illustrious brother, he never lost sight of the object of promoting, as far as possible, the welfare of the

many. In one of his letters, written home at this period, he says: "besides directing these establishments with a view to increasing as much as possible the profits of the Prince, I must contrive, as much as may be, to ease the workmen of the oppression they have of late been subject to." Besides these duties he had assumed the command of a battalion; where his personal attention to the health and comfort of his men was constant, and his inventive ingenuity ever directed towards these objects. It is related that one of the sanitary precautions which he introduced at this time as a part of military discipline, was, that at the daily parade the surgeon should pass from man to man examining individually their tongues. "Out tongue!" observes Lady Bentham, "may seem an out-of-the-way word of command, but the first symptom of the prevailing disorder was discoverable by the appearance of that member; and when thus detected by the surgeon, the afflicted man was ordered instantly to the hospital, where, in this early stage of the disease, rapid recovery of the patient was almost general."

One of the greatest difficulties which Bentham encountered in superintending these numerous factories was that of personal inspection, it being found impossible to keep the sluggish Russian workmen attentive to their employment, unless they were convinced that they might be observed by their chief at any moment. To meet this difficulty, he determined to carry on the whole of the works in one vast panopticon building, or inspection house, of his own design, from the centre of which he could command a view of all its parts. This ingenious building was visited by the celebrated Jeremy

Bentham—Sir Samuel's brother—who induced the English Government to adopt the idea for the construction of jails. On the breaking out of a war between Russia and Turkey, Bentham was sent to the South with his battalion, all the soldiers of which had been instructed by him both as sailors and shipwrights. On taking the sole command of the arsenal at Cherson, he found an immense stock of ordnance; but so ill had affairs been managed, that the Russians possessed there no navigable vessels, except pleasure galleys, which had been used in conveying the Empress on the rivers. There was no time to construct others; and Bentham determined to make the best of his materials. He reflected that it is not the size of the vessel, but its power of throwing the heaviest weight of metal in a given time, combined with facility in manœuvring, which secures victory; and having strengthened his galleys as well as he could, and fitted them with artillery, he determined to take the command of the flotilla himself against an enemy at least twice as numerous and powerful. Under these disadvantages he engaged the Turks on three separate days, returning victorious on all occasions. For these services Bentham received from the Empress the rank of Brigadier-General, a gold-hilted sword, and the Cross of the Order of St. George. Bentham next commanded the Russian army, guarding the eastern frontier of Siberia, bordering on China; and here he established schools for the soldiers.

After two years in this employment, Bentham returned to England, where his inventive genius and benevolent mind found new employment in conjunction with his brother Jeremy. The house of the Benthams,

in Queen's Square Place, made famous by Hazlitt's writings, speedily became almost a museum of contrivances for shortening human labour. There might be seen machines for planing and making mouldings; apparatuses for making wheels and window-sash frames; saws for cutting veneers of extraordinary thinness; machines for boring, dovetailing, cutting stone, and other things. The fame of this machinery naturally attracted numerous visitors, amongst others Mr. Dundas, a Cabinet Minister, afterwards Lord Melville, who in his seat in the House of Commons announced that an ingenious young Englishman, who had long been in Russia, had returned with ideas and inventions which were destined to open a new era in the manufacturing prosperity of this country. It was this allusion which led to Bentham's being employed permanently by the Admiralty, and the effect was immediately seen in the dockyards and arsenals throughout the kingdom. It was by his direction that the wood mills, metal mills, and millwrights' shops were first established at Portsmouth. He also established, in 1800, his steam dredging machine, a powerful apparatus which proved of immense utility. Subsequently he was appointed to the post of Civil Engineer and Architect of the Navy; but he received but few substantial benefits for his great services from the British Government.

After the peace, he retired with his family to France, for the sake of economy in the expenditure of his small income. After thirteen years' absence, during which his name had become almost forgotten, Brigadier-General Bentham returned to England, where he died in 1831, at the age of seventy-four.

ANECDOTES OF THE EDDYSTONE LIGHTHOUSE.

SITUATED about fourteen miles south-west from the port of Plymouth, and directly in the path of English vessels returning home heavily-laden from foreign parts, the famous Eddystone rocks were long the scene of many a story of maritime disaster. The great seas brought up by the south-westerly winds blowing from the Bay of Biscay and the great Atlantic, broke here with terrific violence, often carrying vessels with irresistible force on to destruction. At other times, during the night or in foggy weather, or when the extensive range of these rocks were covered with high water, richly-laden vessels, guided even by the most cautious captains, frequently came to sudden shipwreck in these treacherous places. To erect a permanent beacon upon the Eddystone was therefore from the earliest times felt to be highly necessary; but the task which even in these days of scientific engineering would be sufficiently formidable, was two centuries ago considered almost beyond the power of man. It was thought that even upon the highest of the rocks no workmen could long stand to their labour, for so steep was the rise of the surface exposed to the heaviest seas that the waters, meeting a sudden check frequently flew upwards to a height of two hundred feet, and with a violence which it seemed could scarcely fail to sweep away any scaffolding or incomplete structure, with all living creatures engaged upon it.

At length an ingenious man, but one whose early

training could hardly have been expected to fit him for a great and bold engineering undertaking, was found willing to attempt the task. This was Henry Winstanley, a retired mercer, and a man of moderate fortune, who resided at Littlebury, in Essex. Winstanley had long been accustomed to exercise his mechanical ingenuity, but chiefly in the construction of machines for playing practical jokes on the unwary. Smeaton, in his narrative of the construction of Eddystone Lighthouse, says—"He had distinguished himself in a certain branch of mechanics, the tendency of which is to excite wonder and surprise. He had at his house at Littlebury a set of contrivances such as the following:—Being taken into one particular room of his house, and there observing an old slipper carelessly lying in the middle of the floor, if, as was natural, you gave it a kick with your foot, up started a ghost before you; if you sat down in a certain chair, a couple of arms would immediately clasp you in, so as to render it impossible for you to disengage yourself till your attendant set you at liberty; and if you sat down in a certain arbour by the side of a canal, you were forthwith sent out afloat into the middle, from whence it was impossible for you to escape till the manager returned you to your former place." Some of his curious tricks were afterwards exhibited by Winstanley in May Fair, where they were known as 'Winstanley's water works,' the public of Queen Anne's days eagerly paying one shilling each for admission.

Winstanley's design was not calculated to give confidence in the result of his undertaking. It was a picturesque and fanciful structure of many sides, some-

what resembling a Chinese pagoda, with numerous galleries, quaint projections, and fantastic ornaments. Its sides were decorated with numerous pious inscriptions in Latin and English; and in the view of it which Winstanley published, he represented himself, with characteristic eccentricity, quietly angling from one of the windows, while the crew of a boat below, moored upon the tranquil sea, were handing provisions to a man upon the rock. But the most ominous part of the design was the announcement that the whole structure was to be composed of no stronger material than wood. Yet the result showed that Winstanley's ideas were far from being so visionary as was supposed. The lighthouse occupied more than four years in building. No works were attempted except in the summer weather, and even then the sea, though calm elsewhere, would sometimes rage with such violence around the rocks that for a whole fortnight together the works would be covered, and all approach to them rendered impossible.

The first summer was spent in making twelve holes in the rock, and securing twelve large irons, on which Winstanley relied for holding the work. It was not until the second summer that the indefatigable mercer and his brave companions, after being a hundred times forced to fly from their work, succeeded in making a solid round pillar, twelve feet high, which for the first time gave the workmen some sort of support and shelter. In the third summer the edifice was raised to the height of eighty feet; and Winstanley, to his great joy, found his work stand out bravely against the first storms. "Being all finished (he says), with the lantern and all the rooms that were in it, we ventured to lodge

there soon after Midsummer, for the greater despatch of the work. But the first night the weather came bad, and so continued, that it was eleven days before any boats could come near us again; and not being acquainted with the height of the sea's rising, we were almost drowned with wet, and our provisions in as bad a condition, though we worked night and day as much as possible to make shelter for ourselves. In this storm we lost some of our materials, although we did what we could to save them; but the boat then returning, we all left the house to be refreshed on shore; and as soon as the weather did permit, we returned and finished all, and put up the light on the 14th November, 1698; which being so late in the year, it was three days before Christmas before we had relief to go on shore again, and were almost at the last extremity for want of provisions; but by good Providence, then two boats came with provisions and the family that was to take care of the light, and so ended this year's work."

The fourth year was spent in strengthening the supports, and so confident did Winstanley feel of the stability of his edifice, that he declared his wish to be in it during the most tremendous storm that could arise. This wish he unfortunately obtained; for it was his singular fate to perish in it during the dreadful storm on the 27th of November, 1703—made memorable by the inimitable narrative of Defoe. While Winstanley was there with his workmen and light-keepers, the tempest began. It raged most violently on the night of the 26th of the month, and appears to have been one of the most tremendous ever experienced in Great Britain. The next morning, at daybreak, the hurricane increased

to a degree unparalleled; and the lighthouse, no longer able to sustain its fury, was swept into the deep, with all its ill-fated inmates. When the storm abated, about the 29th, people went off to see if anything remained, but nothing was left save a few large irons, whereby the work had been so fastened into a clink that it could never afterwards be disengaged, till it was cut out in the year 1756. The lighthouse had not long been destroyed, before the "Winchelsea," a Virginian ship, laden with tobacco, for Plymouth, was wrecked on the Eddystone rocks in the night, and every soul perished.

Strangely enough, the next person who, undaunted by the ill fate of his predecessor, undertook to execute the task of erecting a permanent lighthouse on the Eddystone rock, was also a silk mercer. His name was John Rudyerd, and he kept a shop on Ludgate Hill. It is reported that Rudyerd's parents were vagrants, and his family notorious as bad characters; but Rudyerd had raised himself to a position of respectability, and by his ingenious turn for mechanics, had won the confidence of one Capt. Lovet, who had obtained a lease of the Eddystone rock from the Trinity House for the purpose of erecting the light. Rudyerd worked on an entirely original plan, and successfully completed his work in three years. Instead of a polygon, like Winstanley's erection, he chose a perfectly circular form for his building, and carried up the elevation in that shape; and instead of mere wood, it was built of granite and solid oak timber, and was, on the whole, a far more weighty structure than the pagoda of the unfortunate Winstanley. Rudyerd's lighthouse successfully resisted the storms of forty-six years, and was at length destroyed,

not by water, but by fire. In connection with the men employed in the duty of watching in this lonely dwelling in the sea, a singular anecdote is related by Smeaton in his "Narrative:"—For many years it was attended by two light-keepers only, whose duty it was to keep the windows of the lantern clean, and to watch four hours alternately for the purpose of snuffing and renewing the candles. It was the task of each at the conclusion of his watch to call the other, and see him on duty before he went to rest. For this purpose two men were long considered sufficient; but a tragic incident which occurred at this period led to a change in this respect. It happened that one of the watchers in this lonely building was suddenly taken ill, and soon died. The survivor, who had tended his comrade in his sickness without assistance, had now no means of making any one acquainted with his situation. When the light-keepers stood in need of anything, it was their custom to hoist a large flag from a staff in the upper gallery, which could be seen in fine weather from the heights on the mainland. A reward of half a guinea was offered to the person who at any time would bring information of this flag being exhibited to the agent at Plymouth; and on receiving such information, the agent immediately sent a boat, if the weather would permit, to ascertain the meaning of the signal. Accordingly, the surviving light-keeper hoisted his flag, which was speedily observed on shore; but, unfortunately, the weather was for a long time so boisterous that it was impossible for any boat to approach the rocks. During this period, as Smeaton relates, the living man found himself in a most awful and distressing situation; he knew not how to

dispose of the corpse; for if he threw it into the waves, which was his only means of getting rid of it, he feared that he might be charged with the murder of his companion, for stories had frequently been told of quarrels between the men when shut up in their singular prison; and yet each day that the body remained it was endangering his own life by the extremely offensive condition to which it was reduced. When, at last, the people from the boat effected a landing, they found the whole building filled with the most insufferable odour, and the dead body in such a state that it was impossible to remove it to Plymouth for interment; they therefore consigned it to the sea, but it was a long time before the rooms could be purified.

This circumstance induced the proprietors of the lighthouse to employ a third man, so that, in case of a future accident of the same nature, there might be constantly one to supply the place. This regulation afforded relief to the light-keepers; for as soon as three were appointed to the service, a rule was made that in summer each man in his turn should be permitted to go on shore, and spend a month with his friends and acquaintances.

An anecdote is also related in connection with Rudyerd's lighthouse, which shows the strong feeling which existed of the utility of the work to the world. While the workmen were engaged in constructing it, a French privateer suddenly appeared off the rocks, and, seizing the men with their tools and apparatus, carried them to France. While Rudyerd's men lay in prison, the facts reached the ears of the French King, Louis XIV., who not only ordered their release, but restored all their

tools, and sent them back to their work with presents, at the same time declaring that although he was at war with England, he was not at war with mankind.

Rudyerd's work probably would have stood for a much longer period than forty-six years if it had not been accidentally destroyed by fire. This unfortunate circumstance happened on the 2nd of December, 1755. The fire broke out in the lantern at the top of the lighthouse, and the three men who now formed the complement of watchers, after persevering attempts to extinguish the flames, were compelled to retire downwards, from chamber to chamber, as the fire crept on its way. Fortunately, early in the morning some fishermen perceived the strange light in the tower, and intelligence was given of the perilous situation of the poor light-keepers, but the fire had been burning no less than eight hours before assistance finally reached them. The frequent falling of red-hot iron, molten lead, and burning timbers, had not only driven the men from the rooms and staircases, but had compelled them to take refuge in a hole in the rock, where they were found almost stupefied; and whence, the surf being very high, they were only got off by throwing to them a coil of rope, which they had fortunately just sufficient energy to tie round their bodies before jumping into the sea. It is a curious circumstance, related by Smeaton, that no sooner were these men put ashore than one of them disappeared, and was never afterwards heard of. But for the improbability of any man voluntarily subjecting himself to the dangers which the lighthouse men had incurred, it might have been suspected that this man had himself originated the fire. "But I would rather (says Smea-

ton) impute his sudden flight to that kind of panic which sometimes on important occasions seizes weak minds, making them to act without reason, and in so doing commit actions whose tendency is the very reverse of what they desire." Another of the men experienced a singular fate. He persisted in saying that as he was in an upper story of the lighthouse, throwing buckets of water at the fire, and looking up to see the effect of his efforts, a quantity of molten lead had fallen upon his head, face, and shoulders, and that some portion of this lead had actually gone down his throat, causing him great pain. It appeared to the surgeon who attended him that it was impossible that he could have lived through the hardships and fatigues he had endured if he had really received molten lead into the stomach; but subsequent investigation proved that the man's story was correct. On the twelfth day after the accident he was seized with cold sweats and spasms, and soon afterwards expired; and on opening his stomach, Dr. Spry, an eminent surgeon, and member of the Royal Society, discovered in his stomach a solid piece of lead, of a flat, oval form, which actually weighed upwards of seven ounces, and was found with a part of the coat of the stomach firmly adhering to it.

An engineer, pre-eminently fitted to undertake the task of rebuilding the Eddystone Lighthouse, was soon found. This was John Smeaton, one of the greatest, as well as one of the earliest, of our civil engineers. Like Watt, Smeaton begun life as a mathematical instrument maker; but his highly inventive and original mind led him to undertake works of more importance, and finally rendered him famous as the architect and engineer of

some of the most important undertakings in the kingdom. Smeaton having been selected for the work by the Earl of Macclesfield, President of the Royal Society, soon devoted his whole thoughts to the object of making the new building durable. He determined that it should be built of stone; and as the lower blocks were to be ingeniously bonded and dovetailed, on a plan peculiar to himself, he believed that the strength of the building must necessarily be far greater than that of either of the previous erections. After many inspections and laborious preparations, Smeaton himself fixed the centre, and laid down the lines on the 3rd of August, 1756, and continued his personal superintendence, in spite of numerous accidents, till it was completed. The light was first exhibited on the 16th of October, 1759. The lighthouse rose to a height of seventy feet, the last work of the mason being to cut the words "Laus Deo," or "Praise be to God," over the last stone placed over the door of the lantern. Three years after its completion a storm, scarcely less in its fury than that terrible tempest which had swept the unhappy Winstanley and his companions, with all their work, into the sea, raged throughout our coasts; but when the storm had subsided, the stone lighthouse of Smeaton still stood, as it stands to this day, an enduring monument of its designer's energy and genius.

TWO INVENTORS OF EXPLOSIVE COMPOUNDS.

About the end of the last century two inventors in Paris spent their time in the pursuit of certain new explosive compounds, which each believed destined to effect a revolution in the art of war. The first of these was Chevallier, an ingenious machinist and engineer; the second the celebrated chemist Berthollet. Chevallier sought with all the ardour of an alchymist in search of a means of transmuting worthless substances into gold—to discover the lost secret of the ancient Greek fire; Berthollet the solution of the important question of a substitute for saltpetre in the manufacture of gunpowder, that substance sometimes so difficult to procure in times of blockade. Chevallier at length succeeded in preparing fusees which would burn in water, and the effects of which were said to be as sure as they were terrible. Experiments made during certain pyrotechnic displays in 1797, in the presence of distinguished naval officers in the French service, showed that these fusees did actually produce some of the effects commonly attributed to the ancient compound. Chevallier was busily engaged in perfecting his favourite idea, when he fell a victim to an unfortunate chain of circumstances. He had been known as an ardent republican, and had been arrested as the suspected agent of a Jacobin plot. Denounced to the police in 1800 as constantly engaged in preparing destructive inventions of a new kind, he was at once suspected of being engaged in a plot against

the life of the first consul. The groundlessness of this charge was satisfactorily shown; and Chevallier was about to leave his prison, when an attempt upon the life of Bonaparte by means of an infernal machine brought suspicion once more upon him. To be suspected, at that period, was almost synonymous with guilt. Though Chevallier had manifestly no connection with the horrible plot, the unfortunate inventor was in a few days brought to Vincennes, hurriedly tried by a military tribunal, and condemned to death, the sentence being immediately carried out in the fosse of the fortress.

The researches of Berthollet, though less unfortunate in their results for himself, proved even more disastrous to those with whom he came in contact. Berthollet discovered that, on rapidly grinding in a bronze mortar a mixture of chlorate of potash, sulphur, and charcoal, a succession of detonations were produced, while purple flames were seen to rise out of the vessel. These facts suggested to him the substitution of chlorate of potash for saltpetre in the manufacture of gunpowder. The experiments which he undertook with this view appeared to produce the most successful results. A mixture of sulphur, charcoal, and chlorate of potash, in the usual proportions of the ingredients of gunpowder, was found to possess an explosive force so great that projectiles were cast by it three times the distance which could be reached with equal quantities of ordinary powder. Encouraged by this extraordinary result, Berthollet appealed to the government for the means of carrying on the manufacture on a much larger scale, and the government gunpowder manufactory of Essones was at once placed at his disposal. Here the enterprise, how-

ever, speedily came to a terrible end. M. Letort, the manager of the manufactory at Essones, was filled with confidence in the success of Berthollet's experiments, and in the future triumph of the new compound. He went so far as to assure even the inventor that there was nothing dangerous in the process of manufacture, the mixture being, according to him, identical in this respect with the ordinary powder. On the day when the manufacture commenced, he invited Berthollet to dinner, after which he descended with his guest into the workshops. Here they found the mixture being manufactured as usual in mortars with wooden pestles, and through the medium of water, intended to avoid the heat occasioned by friction. M. Letort asserted that the use of the water was a needless precaution, and that the composition might with impunity be ground while dry. To prove this he approached one of the mortars, and with the end of his walking-stick began to rub off a small quantity of the composition which lay dry upon the edge. Instantly a terrible explosion was heard. The house was blown down, and among the ruins were found the bodies of M. Letort, his daughter, and four workmen. Berthollet was preserved by a miraculous accident.

Notwithstanding this check, so important was the object of Berthollet's researches that, four years afterwards, the French Government authorized a further trial. Precautions against accidents were multiplied, and the inventor was still sanguine of success. But all was useless. Scarcely had the operation commenced, when another explosion blew the factory, with three unfortunate workmen, into the air, spreading destruction

around. Henceforth the experiment was abandoned; and it is now known that the objections to chlorate of potash must for ever forbid its use. So dangerous is it that even the movement of the vehicle in which it is carried will cause it to explode; while its sudden action, not only against the projectile, but against the sides of the cannon almost always leads to the bursting of the arm.

MACADAM'S IMPROVEMENTS OF HIGHWAYS.

At the beginning of the present century the commonest kind of carriage-way in the cities of England was a rough pavement formed of flints or ill-shapen stones, called "rubble;" but in places where gravel abounded rounded stones were used, called "boulders." These materials never consolidated, and therefore were always uneven; and, as the art of carriage-building was then in a comparatively rude state, a constant and most uneasy motion was experienced by all who, from their business, or by reason of their rank, were compelled to ride.

One of the earliest of our reformers in this field was Mr. Macadam, whose name, having been given to the kind of road-making which he introduced, has become familiar to all both in England and on the Continent. Macadam, who was a Scotchman, was for some time one of the trustees of the roads in Ayrshire, a fact which led him to think upon the subject of our highways. Coming to England, he obtained the appointment of

government agent for victualling the navy in the West of England, an employment which had little connection with road-making; but his busy and observant mind was still occupied with the subject. To secure the two conditions of road-making—a firm-setting and lasting substance, and a comparatively smooth surface—was to his mind of far more importance than to pass the solemn enactments about the breadth of the fellies of wheels which the legislature had hitherto relied on for keeping up the great highways. The evils of the existing system had become so notorious as to be the subject of a parliamentary inquiry. Mr. Macadam, although he had little practical experience to point to, immediately started for London, and one morning presented himself before the Committee of the House of Commons. He stated that he had ideas on the subject which he believed to be of importance, and the committee immediately gave him a hearing. He told them in his broad Scottish accent that their roads never could be better while they made them of gravel and round stones, which, having no points of contact, never settled into a firm bed. The continual breaking up of roads, by which so many fatal coach accidents annually occurred, were, he said, no fault of the materials, which were not worn out, but only out of their proper place. His remedy was simple enough. Some of his views have been proved to be over sanguine, but his plan has too long competed successfully with other systems for us to have any doubts of its merits. He told the committee, that, on his plan, the maximum depth of the hard road material need be no more than ten inches; that freestone would make as good a road as any other

kind of stone; and that it did not matter whether the substratum was soft or hard. When he explained that his plan was simply to break up blocks of granite into pieces of about the weight of six ounces, and lay them on a convex roadway, soft or hard, taking care by constant raking to keep the roadway free from ruts, until the materials were consolidated into a road, which, according to Macadam, would then last for years, the old-fashioned roadmakers who had assembled to give evidence laughed heartily at the presumption of the amateur roadmaker who had come all the way from a Scottish country town to teach them their business. But the manifest earnestness of the witness prevailed. The bumping to which the aristocratic members of the committee had so long been subjected when travelling post on the highways or riding about town, made them readily give ear to a proposition for their ease and comfort from a man who, at all events, had faith in his own theories. It was determined that an experiment should be immediately made. The experiment appeared to succeed, notwithstanding the serious disadvantage of the dust created by the wearing off of the particles of granite by the friction of carriage-wheels, and the system spread with extraordinary rapidity. Straightway the paving-stones were torn up, broken to pieces, and spread over the streets of London. The change was easily effected. In most cases the stones were already there, and nothing but labour was required. The cities and towns followed the example of the metropolis, the villages and hamlets followed the towns, and gradually all England may be said to have become macadamized.

From this period the enthusiastic Macadam aban-

doned his old employment, and devoted himself entirely to his favourite occupation of road-improvement. He obtained the appointment of Surveyor-General of the Bristol roads, where he was fully at liberty to carry out his notions; but, like most enthusiastic improvers, Macadam failed to make his schemes profitable to himself in a pecuniary sense. He had spent in experimenting and putting his method in execution some thousands of pounds of his own money, a fact which was fully established before a Parliamentary Committee. As a result, the amount thus sunk by him was returned by Parliament, who also presented him with a sum of two thousand pounds in recognition of his services. Macadam had said that, if he died poor, he would at least die an honest man; and both these anticipations were realized. The originality of his system has been denied, a similar plan having, according to some writers, long been in use in Sweden and Switzerland; but, even if this were true, the world owes much to Macadam for that activity of mind and perseverance to which we are indebted for the great difference between the highways of our time and those over which our forefathers were contented to jolt and rumble throughout the kingdom.

CHLOROFORM AND ITS FORERUNNERS.

The idea of abolishing or diminishing the pain of surgical operations is as old as surgery itself. It has, in fact, occupied the minds of men of science at all periods.

The use of opium, cold applications, freezing with ice, compression, and even intoxication by alcohol have been in turns the subject of experiments. The famous Mesmer gravely announced instances in which painless operations had, as he alleged, been performed on patients when in a state of coma produced by animal magnetism, but the facts of mesmerism have never received recognition by the scientific world. After a great number of useless efforts, the abolition of pain in surgical operations became regarded among surgeons pretty much as the search for the philosopher's stone was regarded among natural philosophers. In 1828 an English physician, named Hickman, despairing, we presume, of obtaining a hearing on this subject among his professional brethren at home, addressed a letter to the French king, Charles X., assuring him that he had discovered the means of procuring insensibility among surgical patients. The letter was referred by the king to the Academy of Medicine in Paris, where the reception it obtained strongly evidenced the opinion then prevailing of the hopelessness of any further pursuit of this long-cherished dream of science. The Baron Larrey, the celebrated surgeon, alone advocated the propriety of giving the Englishman a hearing. The rest of the members formally opposed the proposition for proceeding in the matter, which thus fell to the ground. In a well-known treatise on surgery, published in 1839, the writer observes: "The idea of putting an end to pain in surgical operations is a chimera which sober science in these days has ceased to pursue. The surgical instrument and physical suffering are two ideas which are inseparable in the minds of sufferers, and

which we must necessarily admit must always be associated together." Such was the attitude of science towards this question when, in 1846, what is called the anesthetic method suddenly burst upon the attention of the medical world.

The experiments of Davy upon the effects of the respiration of nitrous oxyd first led the way to really scientific inquiry in this field. Davy said that pain was always diminished after the first four or five inspirations, and he added that, as this gas appeared to enjoy, among other properties, that of inducing insensibility to pain, it might probably be employed to advantage in surgical operations not occasioning any great effusion of blood This suggestion attracted but little attention in England, where the public were chiefly interested by the more romantic side of Davy's discoveries—the singular effects of the gas upon the intellectual faculties. It happened, however, that a poor dentist in the United States, a man of little scientific information, on reading Davy's singular narrative, was struck more particularly by this idea. This was Horace Wells, of Hartford, a little town in the State of Connecticut. Wells first essayed upon himself the effects of the gas. While under its influence, he had arranged with one of his family to extract a tooth from which he had suffered. The experiment was made with success. He felt no pain in the operation, and he subsequently continued his experiments upon other persons. Extending his inquiries into the effects of other agents, he employed sulphuric ether with the same results; but being advised, as he states, by a Dr. Marcy not to use this compound on account of its somewhat violent action, he finally returned to the use of the

laughing-gas. Wells had been in business, in partnership with another dentist, named William Morton, in Boston, where he had failed and been compelled to relinquish his practice. He now determined to return to Boston to announce his important discovery to a more scientific audience. Arrived in that city, he called on his old partner Morton, and also upon Dr. Jackson, an eminent surgeon, to inform them of the facts of his discovery. Professor Hayward and Charles Warren, eminent medical practitioners, were also consulted; and it was agreed that it was important that a public demonstration of the discovery should be made. No operations being about to take place at the hospital for a few days, it was determined to try a simple experiment at once upon some medical students, who were about to assemble that evening at the lecture-room to amuse themselves with the effects of the laughing-gas.

The evening being come, Horace Wells, on the platform of the lecture-room, administered the gas to a patient, who asked to have a tooth extracted. The marvellous results to be expected had been announced to the audience; but, in consequence of the uncertain action of the gas, or probably of its unskilful preparation, it produced no result. The patient roared with the pain of the operation exactly as dental patients have done at all times. The spectators laughed, hisses began to be heard, and the scene ended with the retirement in confusion of the unfortunate operator. Wells was a man of a naturally despondent turn of mind. On the morrow he handed over his instruments to his old partner Morton, and retired again to his obscurity in Hartford.

The disappointment he had experienced caused him a severe illness, and when he recovered he abandoned his business of a dentist and his favourite researches in surgery, and for awhile endeavoured to get his living as the proprietor of an exhibition of birds.

The ideas of Horace Wells, however, were not forgotten by Dr. Jackson, who, two years later, applied himself seriously to the study of the subject. Jackson satisfied himself that the laughing-gas of Davy and the sulphuric ether, also tried by Wells, really possessed the properties attributed to them, and these facts he established with far greater precision than was possible with the half-informed dentist, to whom the discovery, however, was due. It was still difficult to obtain patients willing to submit to experiments, and caution was necessary for fear of unexpected results.

Jackson suggested to Morton, the dentist, to continue the use of the new agent in the comparatively simple operations of his branch of surgery. Morton is stated to have been so ignorant as scarcely to have known the name of sulphuric ether, but he had the merit of quickly adopting the suggestion. He tried it, according to his own statement, first upon himself; but he undoubtedly tried it, and with success, upon his patients. Morton, who soon afterwards claimed the merit of the discovery, and actually obtained a patent for the new method in the United States, now induced Dr. Warren to give a public exhibition of its effects in the presence of the students of the Faculty of Medicine and a great number of practitioners of Boston. The operation to be performed was the removal of a large tumour from the neck of a sufferer, who, on recovering from the effects of

the inhalation, declared to the spectators that he had felt no pain whatever during the operation, but only a kind of scratching. The audience, who had now forgotten the ill-starred exhibition of the dentist Horace Wells, broke forth in loud applause, and the meeting ended in great excitement.

The new method, notwithstanding grave objections to which it was open, spread rapidly through the United States, and in Europe the names of Jackson and Morton received universal homage, with expressions of public gratitude as benefactors of the human race. Meanwhile the unfortunate Horace Wells was entirely forgotten. A more complete scientific education, or a conjunction of circumstances more favourable, might easily have led the poor dentist to the full development of the important discoveries to which he had shown the way; but after his public failure at Boston, disgusted with the unlucky results of his experiments, he had altogether renounced his researches. He was leading at Hartford a miserable existence, when news of the extraordinary success of the adopters of his ideas reached him to torture him with regrets for his lack of perseverance. But he determined by some means to get to Europe, to produce evidence of his claims to priority in the new discovery. The history of the affair, however, was at that period very obscure, and he had with him few documents in support of his claims. In London he was everywhere received coldly. In Paris, where he passed the winter of 1847, he could obtain no hearing from those whose influence could procure him justice. Embittered with disappointment, and plunged in poverty, he finally returned to the United States, where he soon

afterwards put an end to his existence. The circumstances of his death were peculiarly mournful. Having entered a warm bath, and opened one of his veins with a surgical instrument, he inhaled a quantity of the ether whose properties he had been the first to demonstrate, and so losing consciousness, gradually bled to death, where he was found by the attendants. While Horace Wells thus perished miserably, says a French writer, whose investigations have established these facts by documentary evidence, Jackson received the Monthyon prize from the Institute of France, while Morton enjoyed the large profits which he derived from the sale of his patent rights.

The spirit of inquiry aroused in Europe by this discovery was not long in producing new fruits. It was soon found that the vapours of a great number of liquids were possessed of properties similar to those of nitrous oxyd and sulphuric ether. It was in the course of researches of this nature that Dr. Simpson, of Edinburgh, arrived at the discovery which has since rendered his name famous. This eminent surgeon had experimented successfully upon a great number of agents calculated to supply the place of ether. Finally he experimented upon chloroform. Although the stupefying qualities of this agent were well known, no surgeon had hitherto thought of it in connection with these experiments, and the announcement of Mr. Simpson of its marvellous effects in 1847, excited great surprise in the medical world. The advantages of chloroform over ether were enormous. The English newspapers spread rapidly the news that henceforth pain was abolished, and the most terrible operations reduced to a

mere trifle. Chloroform became quickly the subject of experiments in all the hospitals of Europe, and everywhere with striking results. Slowly, however, the unwelcome truth dawned upon the public that the labours of science in this direction were yet some distance removed from complete success. Statistics proved with unanswerable logic that hundreds were saved from death by its use in dangerous operations. In the terrible operation of amputation of the thigh, in the hospitals of France, Scotland, and England, from thirty-eight to sixty-two in a hundred of the patients had died before chloroform was employed; while, after the use of that beneficial agent, only twenty-five in a hundred cases terminated fatally. In less dangerous operations the results were still more striking. In fact, pain is itself destructive of human life if prolonged, it being a recognized maxim that painful surgical operations cannot be expected to result in saving the lives of patients if extended over more than three-quarters of an hour. So far the discovery of Dr. Simpson is of the highest importance to humanity; but numerous instances have shown that the employment of chloroform is attended with danger. Science, which has already effected so much, however never stands still; and it may reasonably be expected that the enthusiastic hopes with which the world received the news of the power of chloroform may yet be realized, and pain, at least in surgical operations, be for ever abolished.

REPEATING CROSS-BOWS.

Among the arms captured at the Taku forts, in our last war with the Chinese, were some cross-bows, capable of discharging a dozen bolts, or arrows, in rapid succession, and bearing the same relation to an ordinary bow that Colt's revolver does to a common pistol.

The specimens of these curious weapons which have been brought to Europe seem to be of quite recent manufacture; but the date of the invention has, so far as we know, not been traced, and is very likely to be old.

The stock of the repeating bow is made of wood, and bears some resemblance to the European pattern. At the handle end of the stock is a cross piece of wood, and about two-thirds down is a large wooden peg. When the instrument is used, the left hand grasps the peg, and the cross piece at the end of the stock is pressed firmly against the thigh, or some other support. With his right hand the archer seizes a handle which works up and down like that of a pump. The lower part of this handle is attached by a pivot to the bow stock, and a few inches behind this pivot is another one, by which the handle in united to a hopper; which requires special description, for herein consists the merit of the contrivance. The reader must imagine a very narrow wooden trough, just wide enough to admit one bolt, and deep enough to carry a dozen, one on the top of the other. Just above the bottom of this trough is a slit in which the string of the cross-bow can play.

We must now suppose the hopper filled with bolts, and the handle thrown forwards. By this action the hopper is made to glide forwards over the bow stock, and over the bow-string, which slips in the groove. When this motion has been continued as far as the adjustment allows, the bow-string falls into a notch, and is held fast. As soon as the bow-string falls into the notch, one arrow drops to the level which the string previously occupied. The handle is then pulled back, carrying the string with it in the notch, and stretching the bow. As soon as the handle is sufficiently retracted, the notch is drawn below the string, and the bow discharged, the arrow escaping through a tubular hole. The same actions, which can be repeated with great rapidity, shoot forth twelve arrows in rapid succession. The bow is composed of several flat pieces of thick bamboo, and the string is of gut, like a lathe band.

The bolts, or arrows, are of light wood, tipped with iron, and furnished with feathers, that project very slightly above the surface. Accurate aiming would probably be difficult with such a machine, but it is easy to throw a succession of arrows tolerably near a mark fifty yards off; and with a little practice on the part of the archer, an enemy would find himself very unsafe at that distance.

It is remarkable that in the same forts, side by side with these mediæval looking weapons, were finely-cast cannon, copied from the best models of smooth-bore guns.

WONDERFUL CALCULATORS.

THE possibility of the development of extraordinary powers of calculation in young persons is a fact of which we have now so many instances that it is scarcely possible to be sceptical on the subject. The marvellous stories of the powers of Jedediah Buxton, Zerah Colborne, Mr. Bidder, and more recently of the French shepherd boy, Henri Mondeux, have placed beyond a doubt that even the most illiterate condition is not always incompatible with a skill in calculating and working out intricate problems, which even learned mathematicians may envy. Few of these prodigies in mathematics, however, have been sufficiently instructed to give a rational account of the process of self-education which, however great their natural powers may have been, they must have passed through. Mr. Bidder, who was originally known to the public as the "Extraordinary Calculating Boy," is, perhaps, the only exception to this remark.

Among other interesting anecdotes of his early life, Mr. Bidder has recently told us, in simple, intelligible words, how it was that, while a boy, and the son of a working mason, he cultivated those powers of mental calculation which have contributed to raise him to his present position of eminence as a civil engineer. "As nearly as I can recollect," says Mr. Bidder, "it was at about the age of six years that I was first introduced to the science of figures. My father was a working man, and my elder brother pursued the same calling. My first and only

instructor in figures was that elder brother; the instruction he gave me commenced by teaching me to count up to 10. Having accomplished this, he induced me to go on to 100, and there he stopped. Having acquired a certain knowledge of numbers by counting up to 100, I amused myself by repeating the process, and found that by stopping at 10, and repeating that every time, I counted up to 100 much quicker than by going straight through the series. I counted up to 10, then to 10 again, making 20, 3 times 10 = 30, 4 times 10 = 40, and so on. This may appear a simple process, but I attach the utmost importance to it, because it made me perfectly familiar with numbers up to 100; they became, as it were, my friends, and I knew all their relations and acquaintances. You must bear in mind that at this time I did not know one written or printed figure from another, and my knowledge of language was so restricted that I did not know there was such a word as multiply; but having acquired the power of counting up to 100 by 10 and by 5, I set about, in my own way, to acquire the multiplication table. This I arrived at by getting peas or marbles, and at last I obtained a treasure in a small bag of shot. I used to arrange them into squares of eight on each side, and then, on counting them throughout I found that the whole number amounted to 64; and that fact, once established, has remained there undisturbed until this day, and I dare say it will remain so to the end of my days."

"At the period referred to," continued Mr. Bidder in his address delivered to the Institute of Civil Engineers, from which we extract these anecdotes, "there resided in a house opposite to my father's an aged blacksmith, a kind

old man, who, not having any children, had taken a nephew as his apprentice. With this old gentleman I struck up an early acquaintance, and was allowed the privilege of running about his workshop. As my strength increased I was raised to the dignity of being permitted to blow the bellows for him; and on winter evenings I was allowed to perch myself on his forge-hearth, listening to his stories. On one of these occasions somebody by chance mentioned a sum—whether it was 9 times 9, or what it was, I do not now recollect; but whatever it was, I gave the answer correctly. This occasioned some little astonishment; they then asked me other questions, which I answered with equal facility. They then went on to ask me up to two places of figures—13 times 17, for instance. That was rather beyond me at the time; but I had been accustomed to reason on figures, and I said, 13 times 17 means 10 times 10, plus 10 times 7, plus 10 times 3, and 3 times 7. I said 10 times 10 are 100, 10 times 7 are 70, 10 times 3 are 30, and 3 times 7 are 21; which, added together, give the result 221. Of course I did not do it then as rapidly as afterwards; but I gave the answer correctly, as was verified by the old gentleman's nephew, who began chalking it up to see if it was right. As a natural consequence, this increased my fame still more, and, what was better, it eventually caused halfpence to flow into my pocket, which, I need not say, had the effect of attaching me still more to the science of arithmetic; and thus by degrees I got on, until the multiple arrived at thousands. Then, of course, my powers of numeration had to be increased, and it was explained to me that ten hundreds meant one thousand. Numeration

beyond that point is very simple in its features; 1000 rapidly gets up to 10,000 and 20,000, as it is simply ten or twenty repeated over again, with thousands at the end instead of nothing. So, by degrees, I became familiar with the numeration table, up to a million. From two places of figures I got to three places; then to four places of figures, which took me up, of course, to tens of millions; then I ventured to five and six places of figures, which I could eventually treat with great facility; and on one occasion I went through the task of multiplying twelve places of figures by twelve figures, but it was a great and distressing effort."

It is curious that Mr. Bidder is of opinion that the secret of the extraordinary powers of calculation, exhibited in cases like his own, lies rather in the method of cultivating this particular faculty than in any original faculty in the mind peculiarly fitting it for the purpose. In one of his interesting addresses to the Institute of Civil Engineers, he declared that he could detect in himself no particular turn of mind beyond a predilection for figures; and added—"I do not mean to assert that all minds are alike constituted to succeed in mental computations; but I do say that, so far as I can judge, there may be as large a number of successful mental calculators as there are who attain to eminence in any other branch of learning."

The extraordinary "calculating boy" was for some time exhibited in London as a prodigy; but, fortunately for him, he soon obtained an opportunity of entering life in a less intoxicating atmosphere. Having obtained a situation as a clerk in an insurance office, a post for which his powers particularly fitted him, he passed from

thence into the office of the late Mr. H. R. Palmer, the engineer, where he quickly distinguished himself, and finally commenced practice for himself in the profession in which he now enjoys a high reputation.

MECHANICAL SPIES.



The great importance of strict punctuality and vigilance in the night police employed on the French railways suggested a few years ago to a French gentleman, M. Arésa, the idea of constructing a "tell-tale clock"—a very ingenious mechanical contrivance, which enables the superintendent of the guard to detect with certainty any neglect of duty in the men under his orders. The duty of the guard, or policeman, being to pass particular spots at exact intervals during his night patrol, a kind of table dial is placed at such places, and at the times indicated it becomes the duty of the watchman to press his finger upon a small button, or stud, no other part of the apparatus being within his control. On the following day, when the clock is opened, a circular card is found to be pierced with holes, made by the guard at each of his visits, and this card shows at a glance the exact moment of the night when each hole was pierced. The mechanism is stated to be very simple. The circular card is made to revolve by means of the hour wheel of the clock, and the stud which is pressed by the watchman acts on a sharp needle which perforates the card.

Of course, if the card be pierced in a wrong place it affords incontestible evidence that a neglect of duty has taken place, by which the lives of railway travellers have been endangered. The employment of these ingenious mechanical spies has proved highly successful. The temptation to sleep, so natural in night watchers, but often so disastrous in its consequences, is of course greatly diminished where the slightest neglect is certain to be detected.

Messrs. Smith's detector clock, employed in some of our prisons, appears to be similar in principle to M. Arésa's instrument. This apparatus consists of a revolving frame fitted with pins. As on the French railways, the watchman is required at stated periods of the night to touch the little knob, which leaves an infallible evidence of his watchfulness while the other inmates of the prison are wrapped in slumber.

MR. NASMYTH AND THE STEAM HAMMER.

The inventor of the steam-hammer—that marvellous application of steam power which during the last twenty years has played so important a part in our mechanical and engineering enterprises—has recently related some anecdotes of his early labours, which are in the highest degree instructive and interesting. Mr. Nasmyth, who was the son of Alexander Nasmyth, the Scottish landscape painter, owed his original fondness for mechanical

experiments to his father, who, when not engaged in painting, delighted to amuse himself with lathe turning, or making mechanical models; but his chief good fortune was in having for a school companion the son of a small iron founder. In company with this lad, James Nasmyth, when only twelve years old, delighted to spend his half-holidays in the little foundry at Edinburgh; and here, by intently watching the workmen at their labours, he quickly learnt to turn out a number of ingenious articles in wood, brass, iron, and steel. In working the latter material, he tells us that at the early age of eleven or twelve he had already acquired considerable proficiency. At fifteen he made his first essay at constructing a miniature steam-engine. It had a cylinder of only one inch and three-quarters diameter, but it was really a working steam-engine, and performed useful service in grinding up the oil colours which the elder Nasmyth used in his painting. Subsequently he made other such working models for sale, and with the proceeds was enabled to pay the price of tickets of admission to the lectures on Natural Philosophy and Chemistry, delivered in the University of Edinburgh.

The boy did not want for friends. Professor Leslie, of Edinburgh, employed him in making apparatus for his lectures, and some other friends gave him the means of carrying out his devices on a larger scale. About the years 1827 and 1828 the subject of steam carriages for common roads occupied much of the attention of the public. Many tried to solve the problem; and at length young Nasmyth was furnished with the sum of sixty pounds, with which he finished a complete steam carriage, which, in the autumn of 1828, ran, he says,

"many a mile, with eight persons in it." "After keeping it in action two months (says Mr. Nasmyth) to the full satisfaction of all who were interested in it, my friends allowed me to dispose of it, and I sold it a great bargain, to be used as an engine to drive a small factory. I may name that I employed the waste steam of the engine to cause draught by discharge up the chimney. This important use of the waste steam had been done by George Stephenson some years before, but unknown to me."

His subsequent struggles to obtain a proper field for the exercise of his mechanical and inventive faculty, and his first interview with Henry Maudslay, and his cheerful endurance of privations for the sake of indulging his passion for inventing, are also related by Mr. Nasmyth in the modest and simple narrative addressed to a friend,* from which we quote these particulars:—

"The earnest desire to get forward in the real business of life (he continues) turned my attention to obtaining employment in some of the great engineering establishments of the day, at the head of which, both in reality as well as in my fancy, stood that of Henry Maudslay, of London. It was the summit of my ambition to get work in that establishment; but as my father had not the means to pay any premium, I determined to try what I could do to attain my object by submitting to Mr. Maudslay actual specimens of my capability as a young workman and draughtsman; so to this end I set

* J. Hick, Esq., civil engineer, of Bolton. Mr. Hick incorporated these anecdotes of the inventor of the steam hammer in an interesting lecture, entitled "Self Help," delivered by him in 1862, at Bolton, before an audience of working men.

to work and made a small steam-engine, every part of which was the result of my own handiwork, including the casting and forging of the parts. This I turned out in such a style as I should be proud to own now. My sample drawings were, I may say, highly respectable. Armed with such means of obtaining the good feeling of the great Henry Maudslay, I sailed on the 19th of May, 1829, to London, in a Leith smack, and, after an eight days' voyage, saw London for the first time. I made bold to call on Mr. Maudslay, and told him my simple tale. He desired me to bring my models for him to look at; I did so, and when he came to me I could see by the expression of his cheerful well-remembered countenance that I had attained my great object. He then and there appointed me to be his own private workman, to assist him in his little paradise of a work-shop, with the models of improved machinery and engineering tools of which he is the great originator. In the true practical sense, Henry Maudslay was the author of the chief of those engineering tools which are now by their results giving the distinguishing character to the age we are so happy to live in. He left me to arrange as to wages with his chief cashier, Mr. Robert Young; and on the first Saturday evening I made bold to go to the counting-house and speak to Mr. Young as to wages. He asked me what would satisfy me. I, knowing the vast value of the situation I had obtained, and having a very modest notion of my worthiness to occupy it, said, if he would not consider 10s. per week too much, I thought I could do well with that. He little knew that I had determined not to cost my father another farthing when I left home to begin the world on my own ac-

count; so I suppose he imagined I had means 'forbye' the 10s. per week. Well do I remember the pride and delight I felt when I carried to my three-shilling per week lodging that night my first wages. Ample they were in my idea, as I knew how little I could live on, and that by strict economy I could live quite within the 10s. per week. To this end I contrived a small cooking apparatus, that I forthwith got made by a tinsmith in Lambeth, and which cost 6s., and by its aid I managed to keep the eating and drinking part of my private account within 3s. 6d. per week, or 4s. at the outside. I had three meat dinners in the week, and generally four rice and milk dinners, all of which were cooked by my little apparatus, which I set in action after breakfast, placing a small lamp in the situation near it. The oil cost not quite a halfpenny per day; the meat dinners consisted of a stew of leg of beef, the meat costing 3½d. per pound, which, with sliced potatoes and a little onion, and as much water as just covered all, with a sprinkle of salt and black pepper, by the time I returned to dinner at half-past six, I found a repast in every respect as good as my appetite. The stew was done to perfection, and a right savoury mess it was. About half or three-quarters of a pound of such meat yielded, with the potatoes, etc., a most ample dinner. For breakfast I had coffee and a due proportion of a quartern loaf—a real quartern, for it was always weighed, and when it did not turn the scale the full weight was made up by the addition of a cut from another loaf. I am the more particular in all this, to show you that I was a thrifty housekeeper, although only a lodger in a three-shilling room. My cooking apparatus, when at work, stood on

the hob of the grate, and when I returned home at evening the flavour of the stew told that it was a right savoury mess; and so it was in very deed and truth. I have the apparatus by me yet, and I shall have another dinner out of it ere I am a year older, out of regard to days that were full of the real romance of life." Such was the rough school in which one of the most eminent of our mechanical inventors contrived to develop his genius.

It was not until 1834, and when twenty-six years of age, that Mr. Nasmyth was enabled to start in business for himself in a humble way in Manchester—the city which has now so good reason to be proud of his name. All his engineering tools for commencing business were constructed by himself in Edinburgh, where his father was too poor to give him much assistance. It is related that on one occasion, being altogether without the means of obtaining material for making a brass wheel for a planing machine, he cast his eye upon a glistening row of antique candlesticks made of this metal, which stood in orderly arrangement upon the mantelpiece of the kitchen in his father's house. They were of good metal, and were just the thing for his purpose; but to hint at melting them down was to propose a sort of sacrilege, for Alexander Nasmyth had had, as he said, "many a crack" with the poet Burns while these family candlesticks had stood upon the table. At the mother's request, however, the sacrifice was consented to; the candlesticks were carried off at once to the little workship, and recast into the wheel of the planing machine, which was recently still to be seen in one of the workshops of Mr. Nasmyth in Manchester.

The idea of the steam hammer—which has been

designated "one of the most perfect of artificial machines, and noblest triumphs of mind over matter that modern English engineers have yet developed"—was suggested by a practical difficulty which arose during the construction of the "Great Western" steamship, in 1837. Originally designed for a paddle-wheel steamer, it was found necessary to forge a wrought-iron shaft of thirty inches diameter. This undertaking would now be considered comparatively trifling, but scarcely more than twenty years since it was found that there was not in Great Britain a forge hammer capable of accomplishing such a work. Every firm to which the engineer of the company applied, declined the undertaking as impossible; and in the despair of the projectors, they were about to resort to the dangerous substitute of cast iron, when it was determined to consult Mr. Nasmyth. The impossibility of the task with the existing mechanical contrivances was obvious; but he was not easily daunted. He saw at once why it was that existing machines failed; and it is said that on the same day in which he received the application from the engineer of the company, he sketched out and forwarded the plan of the steam hammer which has since become so famous. Like most of the important inventions for saving labour, it was extremely simple. It consisted, indeed, merely of an inverted cylinder, to the piston of which the enormous block of iron constituting the hammer was attached. The rush of steam into the cylinder was so directed as to raise it, and consequently the hammer, to a height whence the escape of steam which was provided for, permitted the enormous mass to fall upon the anvil.

The immense value of this idea has since been placed beyond a doubt; but it was slow in being adopted. A sudden determination to construct the vessel on the principle of the "screw," then coming into use, dispensed with the necessity for so great an employment of power; and Mr. Nasmyth in vain urged upon the great engineering firms to take up the invention as superior to every other tool for working iron into all kinds of forge work. Mr. Nasmyth was still too poor to obtain a patent for it, and he openly offered it to the public, though for a long time in vain; till visiting one day an engineering workshop, belonging to M. Bourdon, at Creusot, in France, he was astonished to find the shaft of a crank forged in one piece, and of so enormous a size that he knew that no English workshop could have accomplished it. "How did you forge that shaft?" inquired the Englishman, eagerly. "With your hammer," replied the French engineer. In fact, at a time when Nasmyth himself had never seen his own design except in the drawing which he had made for the engineer of the "Great Western," a Frenchman, struck with the idea of which he had heard, had successfully put it in execution. On reaching England, Mr. Nasmyth's partner, and their friends, stimulated by this practical illustration of the value of his invention, hastened to obtain a patent at a cost of £280. From that time its use rapidly spread, effecting a revolution in the prices of all kinds of heavy mechanical work. The price of anchors is said to have fallen immediately one half; and an infinite variety of applications of its gigantic power, which even the inventor himself had not dreamed of, were quickly devised.

The steam hammer, however, is not by any means the sole basis of Mr. Nasmyth's fame as an inventor. His steam-engine, on a plan similar to that of the hammer, "Nasmyth's steam-arm," and his circular cutter for toothed wheels, are scarcely less famous. It is satisfactory to learn that the profits of his inventions, and of the business which they brought him, rapidly raised Mr. Nasmyth from the straitened circumstances which had so long cramped his genius. He retired from his engineering business at the end of 1856, since which time he has devoted himself ardently to his favourite pursuit of astronomical studies. Recently his name has again become famous for his discovery of the nature of the sun's surface, of which Sir John Herschel has published an enthusiastic account.

THE WONDERS OF SPECTRUM ANALYSIS.

No discovery has of late awakened more interest among men of science than that which is known as the spectrum analysis, by which the philosopher is able to ascertain the nature of substances though separated from him by incalculable distances. The discoveries of Newton paved the way to this as to so many other brilliant results. He admitted a sunbeam through a small hole into a dark room, and caused it to be sent out of its path by passing through a glass prism, and thus separated from each other the different coloured lights which in their ordinary

combination affect us as white light. Wollaston, trying the same experiment with light admitted through a very narrow slit, so as to diminish the glare, found that not only are there colours in common sunlight, but the whole of the sunbeam when spread out is found to be full of black lines. In 1815, Frauenhofer published a kind of map of this analysed sunbeam, in which six hundred of these bars are shown in the definite groups, shades, and thicknesses in which they invariably appeared, distinguishing the principal ones by letters of the alphabet. These lines have been shown by Kirchhoff to be spaces of darkness where the bright lines have been intercepted in their passage by some unknown medium. Since then men of science have examined other lights than that of the sun, and it has been found that when the light from metallic flames is analysed in the same way, each metallic flame will be seen to have its characteristic bars by which the presence of the particular metal is indicated. The light from sodium, for instance, has a yellow bar or line, and this split in two. When thus examined, says Mr. Huggins, "the appearance of each metallic flame is as peculiarly distinctive as each man's countenance is unlike his fellow's, and fixes his identity." So delicate is this analysis that it is stated that less than a two-millionth part of a grain of sodium will exhibit the well-known yellow band, the unmistakeable indicator of the presence of that metal. Other metals, existing in other substances only in infinitesimal quantities, and which no ordinary analysis could, therefore, ever have discovered, have revealed themselves at once by this new test. Thus have been discovered cæsium and rubidium, the latter a metal

existing in tobacco, in tea, in coffee, and in grapes. More recently Mr. Crookes, in England, and M. Lamy, in France, have, by the same method, and without communication with each other, added one more to our list of metals, by the discovery of thallium by this test.

Not only does this wonderful key to the components of matter detect traces of metals of inconceivable minuteness, but it permits unlimited distance to separate the experimentalist from the substance he examines. As every ray of our sunlight has travelled from the sun to this planet so does it surely bring with it intelligence of the substances which compose that distant orb. No scientific men who have interested themselves in those discoveries now doubt that we are able to determine that nickel, cobalt, aluminium, and other metals familiar on this earth, form portions of the body of the sun. Two inquirers in our day, Mr. W. Huggins and Professor W. A. Miller, have been the first who have undertaken experiments on this system for determining the constitution of the fixed stars. They have shown that the fixed stars have been created on the same general plan as our sun, but with varieties in the grouping of the elements composing each. By the aid of an instrument contrived by them for the purpose, which they designate a spectroscope, they have recently completely examined between forty and fifty of the fixed stars, and have constructed tables of the measures of lines peculiar to each, showing clearly that the elementary bodies familiar on this earth, also in varying proportions, form the constituents of these distant worlds. Among other curious results of the researches of Messrs. Huggins and Miller we have

their explanation of the different colours of the stars, which they attribute to the difference of their atmospheres, which absorb particular portions of the pure light of those bodies.

THE REAPING MACHINE.

About sixty years ago a reward was voted by Parliament to the inventor of what was then considered a machine of the utmost importance to agricultural industry. This was a reaping machine, which was generally regarded, even by farmers, as successful. The new machine began to be employed both in England and abroad; but in a short time practical men were found to discard it, and return to the ancient system of the reaper and the sickle. The fact was that, although extremely ingenious, the implement for which the House of Commons had voted a reward was much too intricate for real work. It was continually getting out of order; and when out of order, its repair was a task far beyond the powers of country blacksmiths. Many years afterwards another reaping machine was devised in one of our colonies, which cut off the heads of the corn and left the straw standing—a fatal objection to its use in this country. It is not to be wondered at, therefore, if farmers begun to be distrustful of new implements for dispensing with human labour in cutting their corn.

Mr. McCormick, the son of an American farmer, was the first to bring into use a really successful machine of

this kind, and one which has been described as "in agriculture as important as a labour-saving device as the spinning jenny and the power loom in manufactories." This machine was the result of a perseverance and patience in overcoming difficulties which can be understood by those who are familiar with agricultural operations. Besides other difficulties which all inventors experience, its inventor found that his machine could only be tested during two or three weeks in each year. When a defect was discovered, before the remedy could be applied to the instrument the harvest was over, and the improved machine had then to wait a whole year for a trial, when probably some new failure required another year's delay. Mr. McCormick, in his narrative of these trials, says:—

"My father was a farmer in the county of Rockbridge, State of Virginia, United States. He made an experiment in cutting grain, in the year 1816, by a number of cylinders standing perpendicularly. Another experiment of the same kind was made by my father in the harvest of 1831, which satisfied him to abandon it. Thereupon my attention was directed to the subject, and the same harvest I invented and put in operation, in cutting late oats on the farm of John Steele, adjoining my father's, those parts of my present reaper called the platform for receiving the corn, a straight blade taking effect on the corn, supported by stationary fingers over the edge, and a reel to gather the corn, which last, however, I found had been used before, though not in the same combination.

"Although these parts constituted the foundation of the present machine, I found in practice innumerable

difficulties, being limited also to a few weeks in each year, during the harvest, for experimenting, so that my first patent for the reaper was granted June 24th, 1834. During this interval I was often advised by my father and family to abandon it and pursue my regular business, as likely to be more profitable, he having given me a farm. No machines were sold until 1840, and I may say that they were not of much practical value until the improvements of my second patent, 1845.

"These improvements consist in reversing the angle of the sickle-teeth alternately, the improved form of the fingers to hold up the corn, etc., an iron case to preserve the sickle from clogging, and a better mode of separating the standing corn to be cut. Up to this period nothing but loss of time and money resulted from my efforts. The sale has since steadily increased, and is now more than a thousand yearly."

This valuable machine was first exhibited in this country in 1851. English farmers saw with astonishment an American implement hitherto unknown, which not only reaped their wheat, but performed the work with the utmost neatness and precision; and a grave official report on the trial of its powers declared that "its novelty of action reminded one of seeing the first engine run on the Liverpool and Manchester Railway, in this country."

A curious circumstance is related in connection with the first trials of the American reaping machines in England. While the experiments were in progress, Mr. Bell, a Scotch gentleman, came forward with a reaping machine, which he was enabled to prove had been constructed by him many years before, and which was

found to be generally little inferior to the best of the American inventions, while in some respects it was considered to surpass them. The general discouragement thrown upon all such inventions by our farmers, after the failures already noticed, had been sufficient to dishearten its ingenious inventor, and Mr. Bell had given up all efforts to bring it into use. Its very existence had almost passed out of his mind, when the public attention being directed to the subject, he was induced to take from a lumber room the machine which, but for the apathy of agriculturists, might already have effected an enormous saving to the country.

THE DISCOVERERS OF ELECTRO-METALLURGY.

ELECTRO-METALLURGY, or the working in metals by electrical agency, had the singular destiny of being discovered at the same moment by two inquirers at the two extremities of Europe. There appears no reason to doubt that the English chemist, Mr. Thomas Spencer, and the Russian professor, Jacobi, were, in the year 1837, pursuing, without any knowledge of each other's labours, separate paths of scientific experiment, which led them, almost simultaneously, not only to the discovery of this important secret of nature, but, also, to some of its most delicate applications.

Volta had but just discovered, at the beginning of the present century, the electric pile, when he observed one of its most remarkable properties, that is to say, the

chemical decomposition effected by the process in substances submitted to its action. This celebrated philosopher demonstrated, as early as the commencement of the present century, the curious fact that a solution of a metallic salt under the influence of the pile became immediately reduced to its elements in such a way that the metal was deposited at the negative pole. This phenomenon became afterwards the subject of a number of experiments which largely contributed to extend our knowledge of the laws of electricity; but as yet nothing indicated that the precipitation of the metal by the electric fluid could be made to serve useful purposes in the arts. In fact, the substance deposited had few of the characteristics of a metal, being generally a sort of black or grey powder, without coherence and without anything like the brightness of a metallic surface.

It was in the month of September, 1837, that a young English chemist, Mr. Spencer, was occupied in testing the alleged results of some recent experiments upon the artificial formation of minerals by the aid of feeble electric currents, and it was in the course of these experiments that accident led to the discovery of the principles which gave rise to electro-metallurgy. While experimenting with the simple electrical apparatus, consisting of a disk of copper united by a wire to a disk of zinc, Mr. Spencer observed that in covering the wire as usual with sealing-wax some drops of the wax had happened to fall upon the disk of copper. The process of obtaining the weak current of electricity requiring him to steep this disk in a solution of sulphate of copper, Mr. Spencer, on removing it, found, to his surprise, that the particles of copper had been deposited on the edges

of the little spots of wax referred to. He saw, with eager curiosity, that the metal thus precipitated had all the coherence and the brightness of copper after fusion. Mr. Spencer, as he states in his narrative, saw at once that he had the power to direct at his will the deposit of copper. Further experiments confirmed this impression, when, fortunately, another accident led him to still further developments of his discovery. One day when engaged in these inquiries, having no copper disk at hand, he substituted a copper coin, which he connected with a piece of wire to a circlet of zinc. The copper piece was then steeped in the solution as usual, but after some hours, the process not appearing to go on favourably, he removed the apparatus, and began to take off piece by piece the copper precipitated upon the metal. He was scarcely surprised to find on examining them that the figures in relief on the coin and all the finest details of the piece were reproduced with remarkable fidelity in a kind of mould fitted for making a casting of the coin. To reverse the process, and to obtain from a mould a reproduction of the penny piece, was simple. Early in 1838, copies produced in this way were exhibited in Liverpool, and some having been submitted to an experienced medallist at Birmingham, he declared his opinion that they had been struck, merely remarking that the reverse appeared to have been somewhat modified by the employment of acids. The practical medallist added charitably that he advised Mr. Spencer not to endanger his reputation by attempting to pass off any farther mystifications of the kind.

Meanwhile Dr. Jacobi at Dorpat in Russia had, in the month of February of the same year, discovered

that plastic character of copper under the conditions referred to, which was the origin of his labours in electro-chemistry. By the employment of the weak currents exactly as Mr. Spencer had done, he ultimately succeeded in producing in relief an exact impression of a design engraved by himself in the mould made for the purpose. This impression, the first satisfactory result of his researches, was presented to the Academy of Sciences at St. Petersburg on the 17th of October, 1838. The Minister of Public Instruction presented it to the Emperor, who immediately furnished to Jacobi the funds necessary for continuing his researches. The discovery of Jacobi caused great excitement in Russia. The metal dome of St. Isaac's Cathedral at St. Petersburg, which weighs nearly two thousand tons, was soon afterwards electro-gilded with two hundred and seventy-four pounds of ducat gold, and many other applications of the process were made in public works.

MR. GOLDSWORTHY GURNEY AND THE BURNING WASTE OF CLACKMANNAN.

About forty years ago a gang of illicit distillers—such as were common in Scotland—exercised their unlawful trade in the neighbourhood of the town of Stirling. Compelled to seek shelter for their apparatus in waste and solitary places, they found, after many changes, what appeared to them a spot admirably adapted for carrying on their secret manufacture. This was a lonely part of the estate of the South Sauchie Colliery. Originally

the owners of those mines had been accustomed to work their mineral riches at this spot, but the old pit had long been abandoned, while shrubs and underwood had overgrown almost every trace of the once busy industry there established. The old workings—rarely now visited by any human being—were the very thing for concealing the illicit whiskey still; and having let themselves down into the pit, the whiskey makers soon erected their rude apparatus, and, with caution, long continued there to prosecute their secret trade. An accident, however, altogether independent of revenue officers, and one which they had little foreseen, finally compelled them to seek for other quarters. One day they discovered that their furnace operating on the sides of the old subterranean passage in which they worked had caused a smouldering fire in the almost exhausted seam of coal. Failing to extinguish it, they were soon compelled by the smoke to abandon their tools and stock, and fly from the place.

After their departure the fire in the old pit continued to smoulder, until the flames issuing forth were observed at night from distant places. A visit to the spot soon showed that a serious calamity had occurred. The fire, which had now reached a point which baffled all efforts to extinguish it, burnt on from year to year until a seam of coal, twenty-six acres in extent, became embraced in it, and the district became known to the people as the "burning waste of Clackmannan." All efforts to extinguish the fire having long been abandoned as hopeless, the Earl of Mansfield, the proprietor of the mine, determined, on the advice of engineers, to build a wall of mud completely round the burning mass, so as to

deprive it, as far as possible, of air. Five years were employed in this work, and no less than sixteen thousand pounds expended. The workmen had to keep up a constant struggle with the terrible element, being driven further and further away as the fire spread. Subsequently many thousands of pounds additional were spent, while the value of the coal in this portion of the property was lost to the proprietors. In spite of the efforts of the workmen, some air was always able to find a passage to the fire, which maintained a smouldering combustion, occasionally breaking forth into a more serious fire through cracks in the ground.

For thirty years this immense subterranean fire continued to rage, spreading alarm through the neighbourhood, when Mr. Goldsworthy Gurney, a gentleman well known in connection with attempts to adapt locomotives to common roads, and other ingenious schemes, undertook to extinguish the burning waste of Clackmannan, and put an end to the evil which had so long afflicted the neighbourhood. Mr. Gurney had already been successful in extinguishing a fire of less importance at the Astley Collieries in Yorkshire; and a parliamentary inquiry into colliery accidents having again drawn attention to the subject, Mr. Gurney was induced to offer his services to Lord Mansfield. His plan is described as having "consisted in pouring down into the mine an immense body of choke-damp, forced in by a high-pressure jet of steam; the quantity to be sufficient to extinguish the fire, the temperature low enough to cool the coaly mass, and the pressure intense enough to keep out all external air." A furnace was constructed above ground capable of burning coal and coke; a boiler was erected to supply

steam; flues and pipes were so placed as to convey the gas and steam to one of the old working shafts of the mine, and a hole was broken through the mud wall below to establish a communication with the smouldering mass. The fire was lighted; the choke-damp (a mixture of carbonic acid and nitrogen) was generated; the steam was brought up to a high pressure; and a jet of steam being admitted into the pipe which conveyed the choke-damp, forced it irresistibly along and into the mine. For several hours was this flood of gas poured in, until the mine contained eight million cubic feet; it was completely filled, and remained so for three weeks. The absence of free oxygen in choke-damp (continues the account of these operations) "put out the fire, and a subsequent stream at a lower temperature cooled the mass; then fresh but damp air was admitted, and was forced for some weeks through all the vacuities of the mine, by which it was found that the temperature lowered a little every day, and at length, on fairly opening the mine, the fire was found to be utterly extinguished." It was not until some time afterwards that the true cause of this singular accident was revealed by a story told in a Scottish newspaper, but unfortunately too late to bring to justice the authors of what was perhaps the greatest fire, as it was certainly the longest in duration, which was ever known.

THE ELECTRO-MAGNET.

In 1838, Messrs. Morse and Smith, American gentlemen, proprietors of the Morse patent, went to Europe to take out letters patent for the apparatus. Mr. Smith relates a curious circumstance in relation to this visit, leading to the discovery of the intensity magnet in operation at Paris—a discovery of more value to them than the obtaining of patents from every government in Europe.

The electro-magnet—the most vital part of the Morse apparatus—which they took with them, weighed no less than one hundred and sixty pounds. As this immense instrument was carried about in England and France, and guarded with great care, the people, and particularly the officials on the Continent, everywhere eyed it with suspicion, evidently imagining it to be an infernal machine, destined to create some awful destruction.

Happening one day, while in Paris, to enter a public institution, they saw a coil of the same form as their ponderous apparatus, but weighing less than a hundredth part as much, performing the same operation that their apparatus was designed for. Simultaneously with their own invention, in fact, a Frenchman had carried out the same idea; but with more success in the details. They were, of course, amazed, and Mr. Smith, turning to Mr. Morse, remarked, "Here is the essence of your magnet distilled, and presented in suitable proportions." Upon examining the construction of the coil, they found it to consist of a vast number of convolutions of very fine

copper wire wound with silk, the wire being, instead of the large size used by Mr. Morse, which was one-sixteenth of an inch, only a hundredth part of an inch in diameter, thus giving the magnet a vast and intense power in a small compass.

This modification of the electro-magnet was at once adopted, and is the form used upon all the electro-magnetic telegraphs in the world.

A BALLOON ROMANCE.

For some years after the invention of balloons by the brothers Montgolfier, aerostatic amusements formed an invariable feature in the public *fêtes* at Paris, the management of this portion of the programme being invariably entrusted to Garnerin, the celebrated aeronaut, whose enthusiasm for ballooning led him continually to devise novel exhibitions of this kind. The last of the occasions on which Garnerin officiated in this way was attended by circumstances so curious that it was long remembered by the French people. It was on the day of the coronation of the Emperor Napoleon, who had placed at the disposal of Garnerin a sum of 30,000 francs to defray the expense of constructing a balloon of colossal dimensions, to be launched into the air, but without conveying any persons in the car. Accordingly, on the 16th of December in that year, at eleven o'clock at night, and at the moment when a grand display of

fireworks came to its aid, the balloon constructed by Garnerin rose from the appointed spot in the Place Notre Dame. Three thousand coloured lamps illuminated the globe, which was surmounted by an Imperial crown, richly gilt, and bore, traced in letters of gold, on its circumference the inscription, in the style of the revolutionary calendar, "Paris, 25th Frimaire, year 13," and the words, "Coronation of the Emperor Napoleon by his holiness Pius VII." The immense structure rose majestically from the entrance of the cathedral at Notre Dame, in which the imposing ceremony of the coronation had that day taken place, and, rising far above its venerable towers, rapidly disappeared amidst the applause of the Parisian populace.

Where the great balloon, left to pursue its own way, would finally alight was a subject of speculation with the idlers in the throng; but it was not until many days later that intelligence was received of its strange career. It was then learnt that a little before daybreak, after the spectacle in Paris, some inhabitants of Rome had perceived a small luminous object shining in the heavens above the cupola of St. Peter's and the Vatican. At first scarcely visible, it increased rapidly, and finally a huge illuminated globe was seen hovering majestically over the seven-hilled city. It remained some time as if stationary, when a slight wind springing up, it again moved away and disappeared in the direction of the south. This was the great balloon of Garnerin. While the unfortunate Pope had been carried off to Paris to submit to the humiliation of crowning the successful soldier of the Republic, the huge balloon, which bore the news of the ceremony, had, by a singular chance,

been carried by the wind in the direction of Italy, and had actually crossed the city of Rome only a few hours after its ascent.

The superstitious might well read in this strange event good or bad omens, according to their bias; but other facts, scarcely less singular, marked the conclusion of this balloon romance. The great construction continued its way, but soon descended to earth, and mounted again more than once, finally falling upon the waters of the Lake Bracciano. The people hastened to draw the huge machine out of the water and read the inscription which told its history. Thus Garnerin's balloon, visiting within a few hours these two far-distant capitals, announced at Rome the coronation of the Emperor at the moment when the Pope was in Paris, and while Napoleon was preparing to place upon his head the crown of Italy. Interpreted by the new Court of the Emperor, such facts might have been construed as of happy augury; but they were attended by circumstances which rendered the whole affair far from pleasing to Napoleon. It happened that in touching the ground in the Compagna Romana the cords of the balloon became entangled for a while in the ruins of an antique monument. For a few moments it appeared as if its course must terminate here; but the wind having suddenly lifted it again, it once more tore away, leaving nothing behind but a portion of the representation of the Imperial crown, which was found hanging, tattered and soiled, to an angle of the monument. This monument was no other than the ancient tomb of Nero.

It may be supposed that this latter fact gave rise, both among the superstitious people of Italy and their

more enlightened neighbours, to all kind of reflections and comments. Many dissatisfied persons did not scruple to make sinister allusions to that Imperial crown, the gaudy image of which had been torn to pieces on the tomb of the famous tyrant of ancient times. All these things finally came to the ears of Napoleon, who did not conceal his annoyance and ill-humour. He forbade any one to speak to him again of Garnerin or his balloons; and from that day the unfortunate aeronaut ceased to be employed.

Meanwhile the unlucky balloon, the cause of all these rumours, was preserved and suspended at Rome to the roof of the Vatican, where it remained until the downfall of Napoleon, in 1814.

COLOUR-BLINDNESS, AND JOHN DALTON.

In the year 1794, John Dalton, the eminent chemist, became a member of the Literary and Philosophical Society of Manchester, and in the same year read a paper before that body entitled "Extraordinary Facts relating to the Vision of Colours." The strange statements of this essay were received with astonishment by the scientific world to whom they were then altogether new. He told his hearers that he had discovered in his own vision, not otherwise defective, a singular incapacity for distinguishing certain colours, such as scarlet and green, which he designated by the name of colour-

blindness; and he related to his audience an anecdote showing how he first became aware of this curious peculiarity. When a boy he had gone to see a review of troops, and hearing the crowd around him speak of the gorgeous effect of the military uniforms in the masses of soldiers manœuvring before them, he asked, in good faith and simplicity, what was the difference between the soldiers' coats and the grass they were walking on, a question which his companions received with derisive laughter and exclamations of wonder. Dalton showed that so far from this defect being peculiar to himself it had probably always existed, and he described the cases of more than twenty persons similarly constituted. Since then, colour-blindness has taken a recognized place among the ills that human beings are "heir to."

The life of Dalton added another name to the long list of men who have risen by their own exertions from poverty and obscurity to scientific eminence. His atomic theory, long resisted, but finally accepted by Sir Humphry Davy, effected for chemistry what the discovery of the law of gravitation effected for physics. Dalton was born at a little village in Cumberland, and was the son of a poor weaver of common woollen goods. He attended a village school till eleven years old, by which time he acquired some knowledge of mensuration, surveying, and navigation; but as early as twelve years of age he had to get his living partly as a teacher at a school and partly as a labourer on a small farm, which his father had fortunately inherited. Teaching subsequently became his chief occupation. It was at Manchester that he first attracted attention; and chiefly by the remarkable series of philosophical papers of which

that on colour-blindness was the forerunner. Dr. Angus Smith thus describes Dalton's life, while living in George Street, Manchester, in the family of the Rev. W. Johns :—"He rose at about eight o'clock in the morning, if in winter, went with his lantern in his hand to his laboratory, lighted the fire, and come over to breakfast when the family had nearly done. Went to the laboratory, and stayed till dinner time, coming in a hurry when it was nearly over, eating moderately and drinking water only. Went out again, and returned about five o'clock to tea, still in a hurry, when the rest were finishing. Again to his laboratory till nine o'clock, when he returned to supper, after which he and Mr. Johns smoked a pipe, and the whole family seems much to have enjoyed this time of conversation and recreation after the busy day." Such was the homely life of one of the greatest of English men of science.

Though making from time to time contributions to scientific knowledge of the highest importance, Dalton continued even in later life to gain his living as a professional chemist, and teacher of mathematics. At length, in 1833, it was announced by Professor Sedgewick, at the meeting of the Bristol Association at Cambridge, that the king had conferred on him a pension of £150 per annum, which was increased in 1836 to £300. Dalton's brother, dying about the same time, the small farm which the father had inherited descended to him, and he passed the brief remainder of his days in what to a man of his simple habits appeared to be affluence. Dalton sustained an attack of paralysis in 1837, from which he never completely recovered, but as late as 1840 he continued to give evidences of the unimpaired vigour of his

original mind by the publication in that year of four essays, "On the Phosphates and Arseniates," "Microcosmic Salt," "Acid Bases and Water," and a new and easy method of analysing sugar. A second and third attack of paralysis having supervened, this distinguished philosopher died in 1844 in his seventy-eighth year.

JOHN PALMER AND THE FIRST MAIL COACHES.

LITTLE more than eighty years have elapsed since the proprietor and manager of a Bath theatre—a gentleman in no way connected with the British post-office—was led to reflect upon the absurdities of the system then prevailing for carrying letters throughout the kingdom. This gentleman, who had devoted the fortune which he had amassed as a brewer in that city to theatrical speculations, was continually annoyed by the delays which he experienced in writing by the post to the ladies and gentlemen who formed the stars of his theatrical company. There were stage coaches even at that period which left Bath on one afternoon, and arrived in London on the following morning. But the post-office authorities of those days refused to avail themselves of such conveyances. They preferred to entrust their letter-bags —exactly as the postmasters of King Charles II.'s days had done—to idle postboys without character, mounted upon worn-out hacks, who were not only unable, as

Palmer said, to defend their trust from highway robbers, but were frequently in league with them. Owing to this system, the Bath manager found that his letters, besides being continually lost, were nearly four days on the road to London.

Vexed and fretted through a long course of years by annoyances of this kind, Mr. Palmer finally determined to take in hand the reformation of the postal system. If a brewer could successfully manage a theatre, why not a post-office? Satisfied by this reflection, he set himself patiently to work to study the details of the existing system as far as a stranger to the post-office could ascertain them; and finally he paid a visit to Mr. Pitt, the Prime Minister, with a full developed scheme, so complete in the knowledge of the subject which it displayed, that officials were astonished. It may seem strange at this day that the chief point in Mr. Palmer's proposals was the carriage of letters, not by postboys, but by regularly appointed mail coaches, carrying guards well armed and accoutred, and conveying the letters at as least as high a speed as was daily accomplished by the Bath stage.

Mr. Lewins, in his historical account of the post-office, has grouped together an amusing account of the obstacles that beset the path of the theatrical manager who had thus ventured to deal with these manifest evils. It was in vain that he undertook, through his system, to bring more money to the revenue than had been obtained from the old one. The "oldest and ablest officers" in the post-office represented the proposed changes as not only impracticable but dangerous to commerce and the revenue. One of the most

eminent of these officers declared that a postal system which did not include mail coaches was "admirably connected in all its parts, well regulated, and not to be improved by any person unacquainted with the whole." This gentleman declared himself and his brother officials "amazed that any dissatisfaction, any desire for change should exist." The post-office, he said, was "almost as perfect as it could be." Another, a Mr. Draper, objected that the post "cannot travel with the expedition of stage coaches." As to the armed guard, it was gravely prophesied that he would be a nuisance, and that he would inevitably "have to be waited for at every ale house the coach passed." With regard to the highway robbers who were continually performing the feat of stopping His Majesty's mails, one of the gentlemen to whom the Prime Minister had referred this important matter, coolly laid down the doctrine that it was useless to oppose them. There were no means (they said) of preventing robbery with effect, as the strongest cart or coach that could be made, lined and bound with iron, might easily be broken into by determined robbers," adding that any further attempt to prevent their depredations would simply lead to worse results than mere plundering, as "when once desperate fellows had determined on robbery, resistance would lead to murder."

Such was the sort of advice which the young Prime Minister received from his subordinates on the subject of Mr. Palmer's scheme. But Mr. Pitt was a man of original views. The proposals of the Bath stage-manager struck his active mind as both feasible and desirable; and on the 24th of July, 1784, the Postmaster General

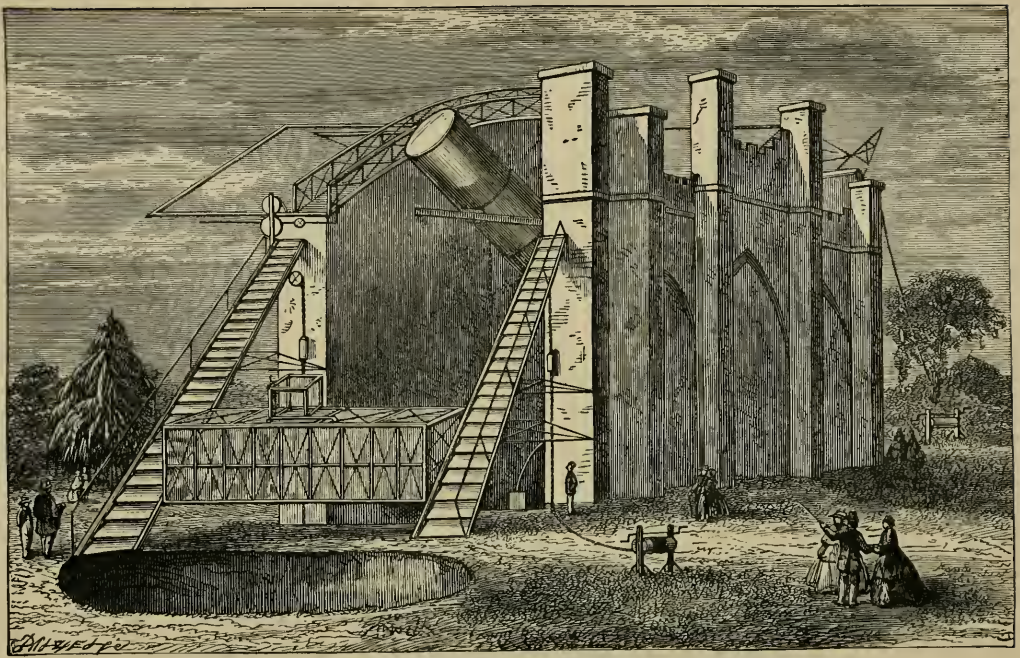
was directed to announce to the public that the Government "being inclined to make an experiment for the more expeditious conveyance of mails of letters by stage coaches, machines, etc., have been pleased to order that a trial shall be made upon the road between London and Bristol, to commence at each place on Monday the 2nd of August next."

The experiment, however, was not tried until the 8th of August, on which day the first mail coach ever seen in this country left London at eight o'clock in the morning, and arrived at Bristol the same night. The distance between London and Bath occupied fourteen hours. The consternation of the objectors to the theory may be imagined when the Bath brewer and theatrical manager was actually installed at the post-office on the day of the change, with the title of Comptroller-General, and with a liberal salary and per centage upon the prospective profits of his system. Though his plans spread rapidly, and the new improvements which he was now enabled to introduce were everywhere hailed with approbation by the public, it was long before opposition finally died out. Lawyers going on circuit were warned not to travel in Palmer's mail coaches, on account of the fearful rate at which they flew, terrible instances being quoted of passengers who were believed to have died suddenly of apoplexy from the rapidity of the motion.

Unfortunately the persecution which Mr. Palmer encountered from his first installation in office does not appear to have been altogether without effect. In spite of the great success of his reforms, he was compelled by circumstances to surrender his appointment, and retire

on a pension of £3000 a-year. This sum proved to fall far short of what Mr. Palmer was entitled to under the original arrangement with the Government; but fortunately he lived to obtain a more just settlement of his claims, which were undeniable. Before his improvements the post office revenue, notwithstanding the extraordinary increase of commerce, had for many years experienced no increase whatever, except what it derived from certain acts of Parliament limiting the system of franks on the one hand, and raising the sum charged for letters on the other. Indeed, for nine years antecedent to the adoption of Mr. Palmer's plans it had decreased by between thirteen and fourteen thousand pounds per annum. But under Mr. Palmer's management it rose from £150,000, at which it had stood in 1783, to £600,000 in 1798, and this with an amazing increase in the circulation of newspapers, which of course added greatly to the stamp duties. To these advantages may be added the fact that mail robberies, of old so fatal in their effects, and so expensive in point of prosecution, from that moment were unknown.

After a long struggle, in 1813, his son, Major General Palmer, induced the House of Commons to acknowledge the claims of his father by a vote of £50,000. Mr. Palmer, who may be regarded as the father of our postal system as it existed up to the time of the inauguration of the penny post, died in 1818.



LORD ROSSE'S GREAT TELESCOPE.

THE EARL OF ROSSE'S GREAT TELESCOPE.

NEARLY two centuries have elapsed since Sir Isaac Newton constructed, with his own hands, the first reflecting telescope—a small instrument of little power, less than a foot in length, and with a speculum of only one inch in diameter. This relic of the great philosopher, which may still be seen in the rooms of the Royal Society, at Burlington House, Piccadilly, though of little practical use even in the early period at which it was invented, is the undoubted parent of that giant tube, through which Herschel first saw Saturn shining in the midst of her satellites; and of those still more marvellous instruments for which science is indebted to the skill, and energy, and inexhaustible perseverance of the Earl of Rosse.

The great reflecting telescope of Herschel, completed by him in the year 1789, had kept its place for more than half a century as the most powerful telescope yet constructed. The enormous difficulties of casting and polishing the metallic speculum for instruments of so great a size, the infinite variety of accidents to which the process is exposed, and the great cost of every failure, had long deterred astronomers even from attempting to imitate it, when, about the year 1827, Lord Oxmantown, a young Irish nobleman, who subsequently succeeded his father as Earl of Rosse, determined to devote himself to the object of constructing a reflecting telescope of even greater power than that

famous "optic tube." Born in the first year of the present century, Lord Oxmantown had distinguished himself at Oxford for his devotion to mathematical studies. After a brief career in Parliament, he finally retired from political life, determined to dedicate his life and fortune almost exclusively to philosophical labours. The astronomer who embarks in this pursuit must depend almost entirely on himself. Skilled workmen capable of rendering him aid cannot be found; the arts which he employs are little known, and the whole process of his labours must be almost entirely experimental. All this Lord Oxmantown well knew, but the difficulties which lay before him only served to awaken enthusiasm. Looking around him in his own neighbourhood, he determined to select his workmen, and to instruct them himself in the work which they were to aid him in accomplishing. All of them, says Mr. Weld, were Irishmen, taken from common hedge schools, and selected in consequence of their giving evidence of mechanical skill; and so well did their master succeed in instructing them, that the foreman, as stated by Lord Oxmantown himself, ultimately became able to execute, unaided, portions of the work which even the genius of Herschel had not succeeded in accomplishing.

It is well known that the chief obstacle to the constructing of these instruments lies in the difficulty of casting and polishing the enormous metal specula or mirrors, which serve to reflect the rays proceeding from the object to be observed to the eye. So great was this difficulty, that even Sir William Herschel, at the commencement of his career, polished four hundred of such mirrors of different dimensions, content if he could

only procure one tolerably good one out of so great a number. From that period up to the time when Lord Oxmantown commenced his labours, no improvements had been discovered in any part of the process. Meanwhile, the great improvements which had taken place on the Continent in the art of making optical glass had brought men to the belief that the old refracting telescope had once more taken the chief place as an astronomical instrument, and that all attempts to improve the reflector were useless. Nothing daunted by this opinion, the young Irish nobleman set to work to consider what were the causes which had hitherto led to failure. He saw that the reflecting telescope had capabilities far beyond those of its rival; while its chief fault, known as "spherical aberration," was common to both. His first object, therefore, was to diminish this fault, in which,—after many ingenious attempts, on a method peculiar to himself, of constructing the mirror originally in three portions, which were afterwards cemented together, and ground and polished into one—he ultimately succeeded. This plan was suggested to him from his having been in the habit of amusing himself in painting on glass. In this latter art the glass is made red hot, and subsequently annealed; and it was while superintending this process that it occurred to him that the precautions employed in this kind of glass manufacture might, with advantage, be transferred to the making of the metallic mirrors.

Aided by his newly-trained band of workmen, Lord Oxmantown then applied himself to the improvement of the process of grinding and polishing. Scientific men among his contemporaries, of considerable reputation,

were of opinion that machinery would be useless for this purpose. He was assured that he could not argue from the manner in which common lenses are manufactured, because with glass, if you made no progress in polishing, you at any rate did no harm ; but that it was otherwise with metal, where the worker is often indebted only to the sense of touch for information, which might otherwise come too late to prevent the spoiling of the work. The motto of the Irish nobleman, however, was "Try," and he did try, and moreover succeeded. He conceived the idea of employing a steam-engine of two-horse power for the purpose, and he invented an entirely novel machine of great ingenuity for accomplishing the difficult process of grinding and polishing, with which, in the course of a few years, metallic mirrors were finished many hundreds of times with a perfection altogether unattainable by hand labour.

Some communications which had been made, from time to time, by Lord Oxmantown to the "Edinburgh Journal of Science" of the results of these labours, soon began to excite the interest of the learned world, who looked eagerly for the results of these persevering experiments. To describe the large number of minor improvements introduced by Lord Oxmantown in the process would be impossible in this sketch. His lordship erected his first great telescope, the result of these labours, on the lawn of his seat at Birr Castle, in Ireland, and, although its speculum was only three feet, while that of Herschel was four feet in diameter, it was not long before scientific men pronounced it to be the first instrument in the world. Such was the perfection of its workmanship, that Dr. Robinson, who made obser-

vations with it in 1840 with the assistance of Sir James South, declared that a large building would be easily visible with it on the surface of the moon, while, in his formal report on the subject, he observes, "It is scarcely possible to preserve the necessary sobriety of language in speaking of the moon's appearance with this instrument, which discovers a multitude of new objects at every point of its surface." Its superiority to Sir John Herschel's famous telescope was fully demonstrated by the manner in which it resolved nebulæ into stars, and put an end to the favourite theory with astronomers of the gradual condensation of nebulous matter into suns and planets, by showing that the supposed globular-shaped nebulæ upon which the theory was founded were no nebulæ at all, but clusters of stars so far remote that their true nature was now only for the first time made known.

In describing this renowned telescope in 1840, its constructor spoke of the possibility of a telescope being constructed with a speculum of six feet in diameter, or twice the size of that with which he had just astonished the world. The project was considered as little better than a chimera by those who were unacquainted with the secrets of the laboratory at Birr Castle. Many denied the practicability of the project, and gave reasons why the attempt must be a failure; but the idea had no sooner occurred to Lord Rosse, than he determined to put it to the test by designing a magnificent instrument, with a metallic speculum of six feet, or considerably more than twice the area of surface of Herschel's great telescope. All being ready, the casting of the speculum took place on the 13th of April, 1842, at nine o'clock in the evening. The crucibles were ten hours heating in

the furnaces before the metal was introduced, which in about ten hours more was sufficiently fluid to be poured. When the oven was opened, the vast metallic mirror, weighing three tons, was fortunately found as perfect as when it entered. Lord Rosse shortly afterwards cast another speculum in the same way of four tons, which was the one ultimately used. This was removed to the grinding-machine, where it underwent that process, as well as polishing, without any accident having occurred. Finally, in October, 1844, the enormous tube, being about forty feet in length and eight feet in diameter, was completed. It is stated that the Dean of Ely walked through the tube with an umbrella up. It was subsequently set up between two lofty walls of castellated architecture, as may be seen in the engraving accompanying this sketch, the elaborate and complicated machinery for moving it—also the work of its constructor—being scarcely less original and ingenious than the telescope itself. Sir David Brewster, who, as editor of the "Edinburgh Journal of Science," was the first to make Lord Rosse's labours known to the world, says, in an eloquent passage, "We have in the mornings walked again and again, and ever with new delight, along this mystic tube, and at midnight, with its distinguished architect, pondered over the marvellous sights which it discloses. The satellites, and belts, and rings of Saturn; the old and new ring, which is advancing with its crest of waters to the body of the planet; the rocks, and mountains, and valleys, and extinct volcanoes of the moon; the crescent of Venus, with its mountainous outline; the systems of double and triple stars; the nebulæ and starry clusters of every

variety of shape, and those spiral nebular formations which baffle human comprehension, and constitute the greatest achievement in modern discovery." The whole weight of the instrument was twelve tons, and its cost to the constructor was estimated at not less than twelve thousand pounds.

Lord Rosse was elected, in 1849, president of the Royal Society, of which he had long been a member, a post which he held for the usual term of five years.

SIR ROWLAND HILL AND THE POST OFFICE.

The numerous stories which were current before the great reforms of Sir Rowland Hill of the ingenious evasions which were resorted to in order to avoid payment of the old absurdly high rates of postage, were undoubtedly greatly instrumental in inducing the legislature to listen to proposals for improvement. These stories were indeed among the earliest things to attract the attention of Sir Rowland Hill himself—then Mr. Hill—to the subject. In his original pamphlet on the Post Office, published in 1837, he tells some anecdotes on this subject, which are significant of the evils of the system then existing. "Some years ago," he says, "when it was the practice to write the name of a member of Parliament for the purpose of franking a newspaper, a friend of mine previous to starting on a tour into Scotland, arranged with his family a plan of informing them

of his progress and state of health without putting them to the expense of postage. It was managed thus. He carried with him a number of old newspapers, one of which he put into the post daily. The post-mark, with the date, showed his progress, and the state of his health was evinced by the selection of a name from a list previously agreed upon, with which the newspaper was franked—'Sir Francis Burdett,' I recollect, denoted vigorous health."

The story of the Poet Coleridge, which has sometimes been attributed to Rowland Hill himself, is better known. Once, during one of the poet's visits to his friends, Southey and Wordsworth, in the lake district, he halted at the door of a wayside inn, at the moment when the rural postman was delivering a letter to the barmaid of the place. Upon receiving it she turned it over and over in her hand, and then asked the postage of it. The postman demanded a shilling. Sighing deeply, however, the girl handed the letter back, saying she was too poor to pay the required sum. The poet at once offered to pay the postage, though this was at a time when, as he tells us, shillings were not abundant in his purse, and in spite of resistance, nods, and winks on the part of the girl, who seemed under some restraint from the postman's presence, he did so. The man had scarcely left the place when the young barmaid confessed that she had learned all that she was ever likely to learn from the letter, and that she had only been practising a preconcerted trick, she and her brother having agreed that a few hieroglyphics on the back of the letter should tell all she wanted to know, whilst the letter, which she had nothing to do but to refuse, should con-

tain no writing. "We are so poor," added the girl, "that we have thought of this way of hearing from one another, and franking our letters."

It was facts like these showing to what almost fraudulent devices poor persons were driven to obtain news of distant relatives and friends, which not only set Mr. Hill thinking of the evils of the system, but determined him to inquire into them. He soon discovered that they were of far greater variety and extent than he had dreamed of; while the anomalies of the system were such as only long habit could have tolerated. He found that while the carriage of a letter to Edinburgh actually cost the Government only the ninth part of a farthing, the public were charged a shilling and three half-pence for it, while letters to places like Louth, where the traffic was so small that every letter costs fifty times as much as a letter to Edinburgh, were charged tenpence. So far from being dependent on distance, he found that the cost of each letter carried bore scarcely any relation to it; and under these circumstances he boldly proposed, in a pamphlet remarkable for its originality and grasp of the subject, that the postage should be made a uniform penny for all parts of Great Britain. This, though the chief feature in his scheme, was far from being the only one; his plan proposing numerous reforms, as greater speed in the delivery of letters, more frequent despatches, simplification in the operations of the Post Office, and other improvements.

As with Mr. Palmer's proposals, the chief officers of the Post Office had stood aghast at the idea of the introduction of mail coaches, so did they receive with astonishment the daring propositions of this unautho-

rized intruder. Mr. Hill was but little known at that time. Born in 1795, the son of a schoolmaster near Birmingham, he began life as a teacher in his father's school. Subsequently he had obtained the post of Secretary to the Commissioners for the Colonization of South Australia, where his talents for "organization" had been discovered and acknowledged by the Commissioners, but of the Post Office he knew nothing but what could be learnt by one of the public. "The first thing I did," he says, in a modest account of his labours, "was to read very carefully all the reports on Post Office subjects. I then put myself in communication with the member for Greenock, who kindly afforded me much assistance. I then applied to the Post Office for information, which Lord Lichfield was so good as to supply me." This we may be assured was not information of a private character. "These," says Mr. Hill, "were the means I took to make myself acquainted with the subject." Such a determination was not easily daunted. When the Post Master-General declared in Parliament that, "Of all the wild and visionary schemes he had ever heard of this was the most extravagant," Mr. Hill persevered in circulating his pamphlet, till at length an interest was excited on the subject among the public, which ultimately secured the success of his scheme. On the 12th of November, 1839, the postage of all inland letters was reduced to a uniform rate of fourpence, and on the 10th of January following, a Treasury Minute announced the complete adoption of Mr. Hill's scheme, and the penny post was from that time one of the institutions of our country.

After filling an appointment for a short time in the

Treasury, Mr. Hill, like his prototype, Palmer, was finally installed in the Post Office to attend to the carrying out of his own plans. Appointed in 1846 as Secretary to the Post Master-General, he obtained in 1854 the office of Secretary to the Post Office, the highest fixed appointment in the office, which he filled until his retirement on account of failing health in 1864. The results of the new system soon justified the most sanguine expectations of its author. Mr. Lewins says, "The publisher of a Polyglot Bible, in twenty-four languages, stated to Mr. Hill that the revision which he was just giving to his work as it was passing through the press, would on the old system have cost him £1500 in postage alone, and that the Bible could not have been printed but for the penny post. Secretaries of different benevolent and literary societies wrote to say how much their machinery had been improved; conductors of educational establishments, how people were everywhere learning to write for the first time, in order to enjoy the benefits of a free correspondence, and how night classes for teaching writing to adults were springing up in all large towns for the same object." In the first year of the new system, the number of letters sent increased threefold; but the development of letter-writing subsequently increased beyond anything which the most sanguine had expected. The number of letters rose from seventy-six millions in 1838 to the enormous number of six hundred and forty-two millions in 1863, while the Post Office returns showed that instead of losing by carrying letters for a penny instead of tenpence and a shilling, the Government had actually gained. In fact, while all the advantages of cheap and expeditious

postage had been secured to the people, the gross returns of the Post Office had risen from £2,346,000 to about £3,870,000, while the clear profit had risen from £1,660,000 to about £1,790,000.

JOHN METCALF, THE BLIND ROAD-MAKER.

How the people of Yorkshire and adjoining counties owed the first improvement of their roads and bridges to a poor unlettered blind man, is related in the singular "Life of John Metcalf," commonly known as the blind road-maker, published early in the present century. Metcalf, whom the country people familiarly called "Blind Jack of Knaresborough," was long an object of wonderment both to the learned and unlearned in the Northern counties, where his labours were considered, even at the time of his death, which took place within the present century, as not inferior to those of experienced engineers.

Metcalf was born at Knaresborough in 1717. When four years old he was put to school by his parents, who were labourers, and he continued at school two years. He was then seized with the smallpox, which rendered him totally blind. Metcalf, however, notwithstanding his affliction, soon displayed remarkable shrewdness. He became an expert swimmer and diver, and during the great floods in his neighbourhood was often employed to recover property sunk in the river or carried

away by the waters. He then taught himself to play the violin, and obtained employment as a musician at Harrogate Assembly-rooms, where he soon became leader of the band. Subsequently he acquired a passion for riding, which he contrived to indulge in without injury to himself; and he saved sufficient money to buy race horses which successfully competed for prizes. When the rebellion broke out in 1745, Metcalf joined General Wade's army, and accompanied them into Scotland with his violin and hautboy. While with the army, and after a variety of adventures, Metcalf contrived to trade in various articles, and to amass a sum of money, with which, in 1751, he commenced a new employment. He started a stage waggon, with a team of horses, between York and Knaresborough, being the first ever established on that road, where the traffic had been previously conducted by the ancient system of pack-horses. The blind carrier constantly conducted this waggon himself twice a week in the summer season and once in winter; the distance between the two towns being about eighteen miles, and this business, together with the occasional conveyance of army baggage, entirely occupied his time until a new occupation again induced him to dispose of his waggon and horses.

In going to and fro on his monotonous journey between York and Knaresborough, the blind carrier, ever and anon encouraging his favourite horses with their jingling bells, to struggle onwards through the rutty roads—had meditated many a time upon the subject of the miserable highways which then formed the only communication between our largest cities. It was not only by choice that John Metcalf's predecessors had

clung to the old system of pack-horses. This he knew by many a disaster to wheel and axle, as his ponderous vehicle bumped and jolted in the muddy hollow places left by wintry rains. What our roads might be if men would mend them, was a question which the solitary waggon-master found a delight in pondering on; and many a time he longed to be allowed to try his ingenuity in the art of road-making. Coming along the road one day in this way, he met with a man who knew him —for most people in those parts knew the blind carrier —and who lent a ready ear to Metcalf's talk on this, his favourite theme. This was Mr. Ostler, of Farnham, near Knaresborough, a man of some ability as a surveyor. Mr. Ostler told the carrier that an Act of Parliament had just been obtained to make a turnpike road from Harrogate to Boroughbridge, and that he had been appointed to undertake the work. Here was the opportunity that the blind waggoner had so long hoped for. Struck by Metcalf's earnestness, and having confidence in his abilities, Mr. Ostler finally consented to allow the amateur road-maker to undertake three miles of the new highway; and Metcalf, abandoning his carrying trade and all its vexations and annoyances, joyfully betook himself to his new employment. "The materials," says the "Life of Metcalf," "were to be procured from one gravel pit for the whole length. He, therefore, provided deal boards and erected a temporary house at the pit, took a dozen horses to the place, fixed racks and mangers, and hired a house for his men at Minskip, which was distant about three-quarters of a mile." He always joined his men by six o'clock in the morning, and by the originality of his whole method of conducting

the work, he completed it much sooner than was expected, and to the entire satisfaction of the surveyors and trustees. During his leisure hours he studied measurement in a way of his own; and when certain of the girth and length of any piece of timber, he was soon able to reduce its contents to feet and inches, and could also bring the dimensions of any building into yards and feet.

"Near the time of his finishing this road," says the writer of the "Life," "the building of a bridge was advertized to be contracted for at Boroughbridge, and a number of gentlemen met for that purpose at the Crown Inn there. Metcalf, amongst others, went also. The masons varied considerably in their estimates. Metcalf's friend, Ostler, was again appointed to survey the bridge; and Metcalf told him that he wished to undertake it, though he had never done anything of the kind before. The surveyor, on this, acquainted the trustees with what Metcalf proposed. When the latter was sent for and asked what he knew about bridge-making, he told the trustees that he could readily describe the structure required if they would take down his words in writing, and he immediately dictated the following statement: "The span of the arch 18 feet, being a semi-circle, makes 27; the arch stones must be a foot deep, which if multiplied by 27, will be 486; and the bases will be 72 feet more. This for the arch will require good backing, for which purpose there are proper stones in the old Roman wall at Aldborough, which may be bought if you please to give directions to that effect." The readiness of this statement determined them to employ him, and the blind road-maker

proved again successful in a new kind of industry. Metcalf's reputation now rapidly increased until he became one of the most important road and bridge contractors then living. He made the roads between Harrogate and Harewood Bridge, between Skipton and Colne, in Lancashire, between Wakefield and Austerland, Chapel-le-Firth and Macclesfield, and numerous other places in Yorkshire, Lancashire, Derbyshire, Cheshire, and other counties. Among other of his occupations he opened new stone quarries, built toll-gate houses, and undertook numerous other works indirectly connected with his new profession. In none of his surveys did he use any implement but his long staff, with which he felt his way over hill and dale, determining the quality of the soil and other particulars. For all these labours Metcalf received large sums of money, and with few exceptions, made profits from his contracts.

This singular man had married early in life, and had a daughter married to a cotton manufacturer who lived in Cheshire. Those were the days of Arkwright and Crompton, and the rumours of large sums of money made in this business, induced the blind road-maker again to turn his attention to new ventures. But this time he appears to have been less fortunate. His biographer tells us that he got six jennies and a carding engine made, with other utensils proper for the business, and bought a quantity of cotton, and spun yarn for sale, as others did in that county. But it cost him much trouble and expense to get his machinery fixed. The speculation failed, and a time came when no yarn could be sold without loss. Nothing daunted, Metcalf then got looms and other implements proper for weav-

ing calicoes, jeans, and velveteens; for having made the cotton manufacture an object of particular attention, he had become well acquainted with its various branches. "He got," continues the author of the "Life," "a quantity of calicoes whitened and printed, his velveteens cut, dyed, etc., and having spun all his cotton he set off with the finished goods to sell them in Yorkshire, which he did at Knaresborough and in the neighbourhood. His son-in-law was to employ his jennies until he came back." But his passion for his late occupation was too strong to be subdued. It is related that on his return from this journey, coming to Marsden, near Huddersfield, where he had made a road some years before, he found that there was to be a meeting to let the making of a mile and a half of road and the building of a bridge over the river which runs by the town, so as to leave the former road in order to avoid the steepness of the hill. Metcalf determined to stay till the meeting, and he agreed with the trustees to undertake the work. The narrator of this anecdote adds, "The bridge was to be twelve yards in the span and nine yards in breadth. These, too, he completed, and received a thousand pounds; but the season being wet, and the ground over which he had to bring his materials very swampy, and at a distance from the road, he lost considerably by it." In the year 1792 Metcalf returned to Yorkshire, and having now retired from his profession, he occasionally purchased hay from the farmers to sell again, measuring the stacks with his arms, and having learnt the height, it is said that he could readily tell what number of square yards were contained, from five to one hundred pounds' value.

Metcalf's biographer tells us that this extraordinary man enjoyed the perfect possession of his mental faculties, and could converse with ease and propriety, still enjoying the company of his numerous friends, until April, 1810, on the 27th of which month he finished his busy career, in the ninety-third year of his age, eighty-seven years of which had been passed in total darkness. The "Gentleman's Magazine" for that year, in recording his death, adds that his living descendants were then "four children, twenty grandchildren, and ninety great and great-great-grandchildren."

DR. ARNOTT AND THE WATER BED.

Among modern men of science to whom the world is indebted for useful inventions tending to promote comfort, or diminish human suffering, none are more deserving of mention than Dr. Arnott, who has successively thrown open to the public all his ingenious devices, generously determining to take out no patent for any one. This ingenious physician has given an interesting account of the circumstances which some years ago led him to construct his hydrostatic bed. All persons who have suffered from a wasting illness, which has long confined them to a bed, are aware of the misery which the pressure even of the softest bed causes to invalids under such circumstances. The case of a lady patient whom Dr. Arnott attended, and who complained daily of her

sufferings in this respect, first suggested to him his ingenious means of mitigating the evil. The lady's sufferings had become so severe as to be almost intolerable. "Under these circumstances," says Dr. Arnott, "the idea of the hydrostatic bed occurred to me. Even the pressure of an air pillow had killed her flesh, and it was evident that persons in such a condition could not be saved, unless they could be supported without sensible inequality of pressure. I then reflected, that the support of water to a floating body is so uniformly diffused, that every thousandth of an inch of the inferior surface, has, as it were, its own separate liquid pillar, and no one part bears the load of its neighbour; that a person resting in a bath is nearly thus supported; that this patient might be laid upon the surface of a bath, over which a large sheet of the waterproof india-rubber cloth had been previously thrown, she being rendered sufficiently buoyant by a soft mattress placed beneath her; thus would she repose on the face of the water, like a swan on its plumage, without sensible pressure anywhere, and almost as if the weight of her body were annihilated."

Having communicated his ideas to a practical machinist, an apparatus was soon completed under the direction of the doctor, who had the satisfaction of seeing it completely successful. The lady gained immediate relief, and ultimately recovered from her malady. Scarcely thirty years ago this contrivance was wholly unknown; at the present day its practical uses are familiar not only in our great hospitals, but among private medical practitioners in England and on the Continent.

THE DISCOVERY OF THE PLANET NEPTUNE.

EARLY in the month of October, 1845, a young student of the University of Cambridge presented himself at the house of the Astronomer Royal in Greenwich Park, and desired to speak with that gentleman. Being informed that Mr. Airy was at that moment in Paris, the young student departed, promising shortly to return. Punctually to his engagement, the stranger soon afterwards again presented himself at the Royal Observatory, but Mr. Airy was still absent. Beginning now probably to suspect that Royal Astronomers are difficult of access, Mr. Adams, for such was the name of the young student, asked for paper, and pen, and ink, and proceeded to put in writing a statement of the object of his visit.

When the note which the stranger had left was placed in the hands of the Astronomer Royal, he might well have been excused if he read it with an incredulous smile. It announced the writer as the discoverer of a sort of hypothetical planet. It professed to be able to state exactly the mean longitude of this accession to our planetary system on a certain day; it even stated its size as three times that of Uranus, and equal to a star of the ninth magnitude. The writer, however, did not profess to have actually seen his planet; he had simply made a series of calculations by which he had satisfied himself not only of the existence of this planet which had hitherto escaped the observation of astronomers, but also enabled himself to state all these and other of

its characteristics; finally, not having himself the means of carrying on practical observations, he requested the Astronomer Royal to proceed upon these data to make a search for this interesting stranger in the solar system.

Without some evidences of scientific attainments in the writer, such a letter would probably have obtained no attention; but the Astronomer Royal's correspondent had reasons to give for his view, and his communication was that of a man of science. Still it did not appear to awaken faith in Mr. Airy: he caused no observations to be made in accordance with the suggestion, but merely answered the letter by suggesting some objection to the theory. Here the matter rested until the 1st of June in the following year, when M. Leverrier, a young French astronomer, announced publicly to the Academy of Sciences in Paris that he had been engaged in a long course of calculations, which were found to have conducted him to conclusions almost exactly identical with those of Mr. Adams.

It is well known that the law of Kepler enables astronomers to determine beforehand the orbit or path of any planet round the sun, when its positions in the heavens at various periods have been ascertained; but the laws of Kepler are not absolutely exact: all that can be said is that they are exact, if we suppose the planets to be acted on by no other attractive power than that of the sun. But the law of gravitation is universal; and the planets are constantly disturbed in the course which they would naturally take, by the attraction of other planets, like themselves compelled to move for ever around the distant centre of our solar system.

These slight irregularities in the movements of the planets are well known to astronomers under the name of planetary perturbations. They are frequently only to be detected by the most delicate operations, and the nicest calculations; but the perfection to which the systems of observation have been brought since the time of Kepler, renders them easily appreciable. Thus the effects of the planets upon the orbit of the new planet Uranus, discovered by Herschel were fully ascertained; but in spite of all calculations, Uranus continued to depart in an inexplicable manner from the path which theory assigned it. The error in the calculations became more and more manifest as from year to year of our time the progress of Uranus in its long journey round the sun became more developed. The "rebel planet" as men of science had learned to call it, had not yet terminated one complete revolution since the time of its discovery by Herschel, when the astronomers had begun to lose all hope of reconciling its movements by those tables which were of such unfailing certainty in all other calculations.

In this dilemma, it is scarcely surprising that the minds of scientific men were busy in inventing theories for explaining the facts. To the imaginations of some, a comet, undiscernible to our eye must be wandering in the neighbourhood of Herschel's new world; according to others, some fluid or other, of an unknown kind, surrounded it, clogging its movements; others again imagined a large satellite which disturbed its path; while one at least had suggested the bold hypothesis, that somewhere beyond the orbit of Uranus another planet, which had hitherto escaped the observation of

astronomers, produced a disturbing influence, which might yet be reduced to fixed rules.

This was the hypothesis on which M. Leverrier had proceeded. With extraordinary industry and patience this young man of science, who occupied only the humble post of teacher of astronomy in the Polytechnic School in Paris, had set himself to verify and correct the whole of the extensive calculations of Bouvard in his famous work designed for the assistance of astronomers in similar labours. Like Mr. Adams he proceeded to the solution of the question of the disturbances in the path of Uranus purely in a hypothetical way. Satisfied that they could only proceed from the action of some hitherto undiscovered member of our solar system, he too inferred the distance of this unknown planet from a certain uniformity observable in the distances from the sun of other planets. He assumed that it would be found that as Uranus is twice the distance of Saturn, so the new planet would be twice the distance of Uranus. Ordinarily in calculations of this kind the astronomer knows the position, and the density of the disturbing planet, and from these data determines its influence, but here the method of investigation was exactly the reverse. The perturbations were known; the cause was unknown. Nevertheless, M. Leverrier proceeded in his laborious course, and finally, on the 1st of June he addressed the members of the Academy of Sciences with the remarkable words—"The planet which disturbs Uranus exists. Its longitude on the 1st of January, 1847, will be 325 degrees, and it is impossible that there can be an error of more than ten degrees in that calculation." A subsequent and more careful investigation

enabled him to indicate more exactly the characteristics of this still undiscovered world. He announced that its density would exceed that of Uranus; that its apparent diameter and its brilliancy would be only a little less, so that not only would it be discoverable by a good instrument, but it would be distinguished without difficulty from its neighbouring fixed stars, from the fact that its disk-like form must be apparent, while the fixed stars even in the strongest telescope appear but as points of light. Finally, he announced that to find it the search must be conducted at a time named, at about five degrees to the west of a certain star in the constellation Capricorn.

Nothing can give a more imposing idea of the exactness of astronomical science than the fact that these bold predictions were not only identical in their most important points with the conclusions of the young English astronomer, which had not yet been given to the world, but were in the end found to be almost exactly correct. For some time no attempt was made to find the planet thus distinctly pointed out; and it must ever remain a slur upon French astronomers that the correctness of this ingenious hypothesis was finally determined not by the Observatory at Paris, but by the Royal Observatory of Berlin. On the 31st of August, 1846, the exact position of the planet was announced; and on the 13th of September the facts were communicated to M. Galle, the Prussian astronomer, who on the very evening on which he had received the request to look for it, was so fortunate as to discover it as a star of the eighth magnitude. The differences between its position and other characteristics, and those predicted were so trifling as to place

beyond a doubt the fact that its existence had been proved before any astronomer had seen it, or, at least, before any one had distinguished it from the fixed stars which surround it. "The honour of having made this discovery," says Sir David Brewster, "belongs equally to Adams and Leverrier. It is the greatest intellectual achievement in the annals of astronomy, and the noblest triumph of the Newtonian Philosophy."

At first it was proposed to give to the new planet the name of Leverrier, but ultimately it was determined to preserve the uniformity in the classical names of the heavenly bodies, by giving it the title of Neptune, by which it is now recognized throughout the learned world. Neptune is thirty times further from the sun than this world, and performs its journey around that luminary in 172 of our years. By its discovery alone our solar system was ascertained to extend one thousand millions of miles beyond the limits which had been previously known.

THE INVENTION OF THE SCREW PROPELLER.

MR. HICK, the engineer, of Bolton, in a lecture delivered by him before an audience of working men in that town, has recently thus told how the idea of the steam propeller was suggested to his late brother, an ingenious inventor of more than one important improvement in machinery: "It was a spirit of observation," said the lecturer, "which led a clever young man of this town,

now no more, to invent a screw propeller for vessels, and it happened in this manner: In taking a stroll one autumn evening in the country, he observed the seeds falling from a sycamore tree, and noticed that they acquired a rotary motion before reaching the ground. This led him at once to inquire into the cause, and taking one up he found that the two wings were slightly turned in opposite directions, which caused them to revolve in falling, and the idea at once struck him of making a screw propeller on this principle."

The lecturer exhibited an interesting model of the propeller referred to; but it must be remarked that the powers of the screw itself have been known from remote antiquity; while the merit of having been the first to practically apply it to the propulsion of vessels, undoubtedly belongs to Mr. Francis Pettit Smith, originally a grazing farmer, who turned his cattle to feed in the broad marshes about Romney, in Kent. Smith was the son of the postmaster at Hythe; neither his own profession nor that of his father, therefore, were likely to direct his mind either to shipbuilding or mechanics in general; but he had, from a boy, been fond of amusing himself with making models of boats, and had contrived various modes of moving them in the water. It was in 1834 that he had at length constructed a model of a boat propelled by a screw driven by a spring, which answered so well that he determined that this would be a better mode of propulsion for steamboats than the paddle, which was then universally employed. Mr. Smith was at this time following his business of a cattle grazier, at a farm which he rented at Hendon, in Middlesex, and on a horsepond at this spot he tried, in 1835, a

number of experiments with a model screw-steamboat of his own making. Some experiments were also conducted by him at the Adelaide Gallery, near Charing Cross; and finally, in 1836, he took a patent for his new application of the screw to the purpose of propelling vessels. In that year, a small practical steam vessel of about ten tons' burden was built by him, and was tried on the Paddington Canal and also on the Thames, with satisfactory results. This tiny vessel actually put to sea in 1837, and visited Folkestone, Dover, and other ports, encountering occasionally very severe weather, by which it was finally demonstrated—in spite of the warnings of professional critics—that the screw would work equally well in rough or smooth water.

In 1838 this novelty in steamboat construction was visited by the Lords of the Admiralty, who undertook to try the invention in the navy; but before doing so they desired to have it tried by Mr. Smith in a larger vessel. To meet this request, the celebrated "Archimedes" was built—a vessel of 237 tons burden and ninety-horse power, and in October, 1838, she was launched on the Thames at Millwall. So valuable was the principle considered by the Admiralty, that it was agreed that her trial trip should be considered satisfactory if she realized a speed of five miles an hour; but nearly twice that speed was attained. The remarkable success of the "Archimedes" took the engineering world by surprise. In 1839 and 1840 the "Archimedes" visited every principal port in Great Britain, and crossed the Bay of Biscay to Oporto, everywhere exciting universal admiration. A number of vessels were now laid down on the screw principle; and by 1850 nearly a hun-

dred screw steamships had been built or ordered to be built.

The history of Mr. Smith's career as an inventor again presents us with the old story of disappointment and injustice. In 1850 his fourteen years' patent had expired, and although an extension of five years had been granted, he had incurred expenses so heavy that the result to the inventor himself was nothing but loss. To add to his troubles, no sooner was the invention of which nobody had augured well in its early stages, a declared success, than a number of persons sprang up to lay claim to it, or to pretend that the idea was an old one, and the patent void. As in the case of Watt, continual litigation was necessary to support his right; and law costs made still further deductions from what should have been the inventor's profits. Mr. Smith has obtained a pension from the civil list, and the leading engineers of the country some time since subscribed a considerable memorial fund to mark their sense of his merits. Only ten years after the first adoption of the screw in our navy it was calculated that if the old paddlewheel had up to that time continued to be in exclusive use, engines of nearly one hundred thousand-horse power additional would have been required than was then necessary; the cost of which would have been five or six millions sterling. In the mercantile navy the saving by the application of the screw is still more important.

THE CHILDHOOD OF DR. THOMAS YOUNG.

Dr. Thomas Young, whose discoveries on the theory of light would, according to Sir John Herschel, "have sufficed to place their author in the highest rank of scientific immortality," has left an interesting account of his studies up to his fourteenth year, which shows how slight are sometimes the circumstances which have directed the minds of our most eminent discoverers to the studies which have made them famous.

Though not born in so poor a station as the present philosopher Ferguson, Young was not less remarkable for the early development of his powers. He was brought up by his grandfather, a merchant at Minehead, in Somersetshire. At two years of age he had learnt to read with fluency; at six he learnt by heart the whole of Goldsmith's poem, "The Deserted Village," which was the work of six weeks, during the hours of his absence from school. Having been placed, soon after this, at what he calls a "miserable boarding-school" at Stapleton, near Bristol, kept by a master who was extremely morose and severe, and, moreover, ignorant of the things he undertook to teach, the lad, now in his ninth year, was kept for six months entirely at home. It was during this time that he first imbibed a liking for philosophical subjects. "My father," he says, "had a neighbour of the name of Kingdon, a man of great ingenuity, who, though originally a tailor, had raised himself, by his talents and good conduct, to a

respectable position in life, being at that time a land-surveyor, and also land-steward to several gentlemen in the neighbourhood. His daughters had always treated me, when a child, with great kindness, and I was in consequence very fond of going to his house, where I found many books relating to science, and particularly a 'Dictionary of Arts and Sciences,' in three folio volumes, which I began to read with the most intense interest and delight. At his house I also found several mathematical and philosophical instruments, the use of many of which I learnt, with the assistance of his daughters and his nephew." Soon after this the child philosopher was sent to the school of Mr. Thompson, at Compton, in Dorsetshire, where he made progress in the study of the classics and of mathematics. "The usher of this school," he continues, "was a very ingenious young man, of the name of Josiah Jeffrey, who was in the habit of lending me books, and amongst them Benjamin Martin's 'Lectures on Natural Philosophy,' and Ryland's 'Introduction to the Newtonian Philosophy.'" This appears to have been the turning point in his early education, and he records the delight which he experienced in reading the optical part of Martin's work, containing, as it does, many detailed rules for the practical construction of instruments.

In the usher Jeffrey the boy was fortunate in finding a congenial mind. "Mr. Jeffrey," he continues, "was a good mechanic, and it was from him that I acquired my fondness for turning and for making telescopes. He also made an electrical machine, which I very frequently used. I was in the habit of grinding and preparing various kinds of colours for him, which he used to sell

to the boys and others. He was also a bookbinder, an occupation in which I assisted him." After Jeffrey left the school, Young succeeded to some of his employments and perquisites, and was thus enabled to save money to buy Greek and Latin books, and also Montanus's Hebrew Bible, for he was at that time enamoured of Oriental literature. But philosophy was his chief delight. "In the intervals of my residence at this school," he says, "during my occasional visits to my grandfather at Minehead, I became acquainted with a saddler of the name of Atkins, a person of considerable mechanical skill and ingenuity, whose journal of the heights of the barometer and thermometer, of the state of the weather, and the direction of the wind for three times a day during the whole of the year 1782, is published in the 'Philosophical Transactions.'" Amongst many other instruments possessed by this learned saddler was a quadrant which he lent to his boy acquaintance, who made it the constant companion of his walks, and attempted to measure with it the heights of the principal eminences in the neighbourhood. He had imbibed also a wish to study botany, from a conversation which he had had with a gentleman of learning in this field, and he longed to construct a microscope from Benjamin Martin's description, in order to examine the minute organs of plants. For this purpose he procured a lathe, and succeeded in getting the requisite materials. His zeal for botany during these operations was replaced by his fondness for optics, and subsequently by that for turning.

"I well recollect," adds Dr. Young in the conclusion of this interesting fragment of autobiography, "that,

having seen a demonstration in Martin which exhibited, although unnecessary, some fluxional symbols, I never felt satisfied until I had read, a year or two afterwards, a 'Short Introduction to the Method of Fluxions.' My father had purchased at an auction a volume of 'Priestly on Air,' the reading of which delighted me greatly, and first turned my attention to making chemical experiments. I was in the habit of rising an hour sooner than my schoolfellows in summer, and of going to bed an hour or two later in winter, for the purpose of mastering my lessons for the day. My school business was thus soon finished. . . . Upon my return home, after finally leaving Compton school, I devoted myself almost entirely to the study of Hebrew, and to the practice of turning and telescope-making."

Such a childhood could hardly fail to lead to distinction in later life. Having chosen the medical profession, in conformity with the wish of his uncle, Dr. Brocklesby, he had scarcely begun life as a physician, when, by the death of the former, he inherited a considerable fortune. From that period his time was in a great degree devoted to philosophy. In 1797 he published his "Outlines and Experiments respecting Sound and Light," the first of his long series of important contributions to natural philosophy. Amongst his more celebrated labours were his researches into hieroglyphical literature and Egyptian antiquities, the results of which were embodied in a curious work published about forty years since.

THE ART OF PHOTO-SCULPTURE.

Not only the latest, but perhaps the most curious and interesting of all the applications of photography, is that by which sun portraits are made to serve the purpose of the sculptor's art. This ingenious invention is due to M. Villème, an eminent French sculptor. Every occasional visitor to sculptor's studios is aware that it has long been common for the artist, while chiselling a face, to refresh his memory or guide his eye by now and then glancing at a photographic portrait placed by his side; for photography, however it may sometimes fail in reproducing the expression of the human face, is unerring in its rendering of the outline of features, with which the sculptor is most concerned. Such was the practice of M. Villème; but the difficulty of communicating to a flat portrait the appearance of a solid form could not fail to be felt during the process. The statue reproducing the face in its complete relief gives its aspect from any point of view which the spectator might choose; the photograph, on the contrary, presents nothing but the particular aspect impressed by the image on the surface of the paper. Feeling this defect, M. Villème would sometimes correct his impression of the face to be copied by obtaining more than one photograph of his subject; but this was, at best, but a rough guide, because the two portraits had not of course been merely taken from different points of view, but from the same subject in different positions.

Reflecting upon these facts, M. Villème was struck by the ingenious idea that a statue in relief is, after all, only a combination of all the profiles of the face or figure in the same position. From this it followed, naturally, that if he could have photographs of several profiles of the sitter taken at the same moment by a number of cameras placed around, he could gradually change his position while at work, and correct his model each time by comparison with the profile outline of each model. It next occurred to him that instead of merely correcting his work in this way, it was simpler to commence at once upon the plastic material and model it gradually all round, following one after the other the outlines of the photographs. "Supposing," says a description of the process recently read by M. Claudet before the British Association, "that the sculptor had twenty-four photographs representing the sitter in as many points of view (all taken at once), he had but to turn the block of clay after every operation one twenty-fourth of the base upon which it is fixed, and to cut out the next profile until the block had completed its entire revolution, and then the clay was transformed into a perfect solid figure of the twenty-four photographs."

For the purpose of this art M. Villème has constructed an ingenious circular chamber, in the centre of which the subject to be modelled is requested to stand upon a low pedestal in a natural and easy posture; while from twenty-four circular apertures in the wall of the chamber provided with photographic apparatus, an equal number of portraits are obtained in a few seconds. By the aid of these photographs the difficult art of modelling a portrait is rendered easy. The least skilful in the

art is by this process enabled to make a model of far greater accuracy than had before been obtainable: while the cost of sculpture is greatly reduced.

HISTORY OF POSTAGE STAMPS.

As with most other modern inventions, certain writers have discovered that postage stamps, or something similar to them, had been thought of long ago. According to M. Fournier, the author of *Le Vieux Neuf*, they were actually in use in Paris in the reign of Louis XIV. Another French writer tells us that they originated in 1653. Monsieur de Velayer established under royal authority a private penny post in Paris on the 16th of August in that year, and issued a notice that all persons desiring to send letters from one part of Paris to another should have them carried, and a prompt reply returned, if they attached to their letters a ticket signifying that the postage rate had been paid. These tickets appear to have had much in common with the modern postage-stamp, for they were stamped with a portrait of the king, and were to be purchased beforehand at certain shops and other places. They were to be charged a sou each, and the public were recommended to buy a number, and have them always at hand. Boxes were moreover placed at the corners of streets for the reception of letters, and letter-carriers were appointed to open these boxes three times a day,

and carry the letters to their addresses, where they waited for answers. The plan perhaps resembled more an organized plan of light porterage than the modern system of posts, but its resemblance to the latter system is curious.

There can be little doubt that the originators of the modern postage-stamp had never heard of Monsieur de Velayer or his scheme, which indeed had long fallen into oblivion even among Frenchmen. Between 1830 and 1834, Mr. Charles Whiting, Mr. Charles Knight, and Dr. Gray had all suggested a stamped wrapper for newspapers. Dr. Gray, of the British Museum, lays claim to have been the first to suggest the prepayment, by means of stamps, of letters. "In the year 1834," he says, "the idea occurred to me that as the postage of newspapers was prepaid by means of stamps, the readiest mode of applying these stamps would be by means of stamped covers. On further consideration of the subject, I became satisfied 'that the great cost of the Post Office was not the reception, carriage, and delivery of the letters, but the complicated system of accounts that the old system required; and having learned from the best writers on political economy that the collection of money by stamps was the most certain and economical,' I came to the conclusion that the new system of newspaper postage should be extended to letters also. 'It was, in fact, the mere application of the system used with regard to newspapers, to letters in general.' This idea I communicated to many of my political and other friends, Mr. Hume, Mr. Warburton, and others, but I found that I could get no attention to the subject."

Even Mr. Rowland Hill, in his famous pamphlet published in 1837, contemplated no system of prepayment, except by money payment at the counters of receiving offices. Meanwhile the subject of prepayment by stamped envelopes having been discussed before a Parliamentary Committee, Mr. Hill, in a second edition of his pamphlet, with characteristic decision, adopted the idea, and warmly advocated its merits. A clause in the Penny Postage Act accordingly foreshadowed the new system, but the idea was at first merely to have a stamped envelope of so elaborate a character that it would almost defy the ingenuity of forgers to imitate it. On the 23rd of August, 1839, the Government issued a public invitation to "artists, men of science," and others, to send in designs for this purpose, offering two prizes of £200 and £100 to stimulate invention. As is well known, Mr. Mulready, the famous artist, was the successful competitor,—his envelope, representing a highly elaborate allegorical picture of considerable artistic merit, though absurdly fantastic as a vehicle for ordinary letters, while the picture, spreading over the surface, left scarcely room for writing the address. So much ridicule was showered upon the new envelope, that in a short time it fell into disuse, and copies of it are now, as all collectors know, comparatively rare.

The Government now offered another reward of £500 for the best design for a new label, the invention of which may be supposed to have been not so simple a thing as it appears, when we learn that, of the designs —numbering nearly one thousand—sent in, not one was chosen. The now familiar Queen's-head which was finally chosen, was said to be the production of officers

in the Post and Stamp offices; but as originally printed in black ink, its appearance was far from pleasing. The black stamp was soon afterwards changed to brown, and finally to the red now so well known. The great varieties in colour since introduced to indicate to the eye the different values of the stamps, are too well known to require mention. "For eight long years," says Mr. Lewins, "the English people may be said to have enjoyed a complete monopoly in postage-stamps. Towards the close of 1848 they were introduced into France, and subsequently into every civilized nation in the world. Last year they even penetrated into the Ottoman Empire, and, strange as it appears when viewed in the light of Mohammedan usage, the Sultan has been prevailed on to allow his portrait to appear on the new issues of Turkish stamps."

Simple and obvious as it now appears, one of the most important inventions in connection with postage-stamps is the perforating machine. Most persons can remember when every post receiving-house kept a pair of scissors, clumsily fastened to a counter with a heavy chain, at which a little file of persons could generally be seen waiting for their turn to cut off a stamp with four careful strokes of that necessary implement; but the number of persons who, not having a pair of scissors at hand, were striving to tear or cut off with a pen-knife one Queen's-head from a strip or sheet, could not so easily be ascertained. The machine, which was the invention of Mr. Henry Archer, at once put an end to all these petty troubles. By the simple process of stamping every sheet with neat lines of perforation, not only could every one keep his postage-stamps together,

and tear them off when wanted, but he could also fold them together with the utmost neatness to put them away in a purse or pocket-book. On the recommendation of a Select Committee of the House of Commons this machine was purchased from Mr. Archer in 1852 for four thousand pounds.

COL. PASLEY AND THE WRECK OF THE "ROYAL GEORGE."

For more than half a century the wreck of the "Royal George," sunk at Spithead in 1782, with all her guns, stores, and crew, had baffled all attempts to raise or remove it, when in 1839 Col. Pasley undertook the task of blowing it up with gunpowder, a plan hitherto unknown in such operations. The story of this famous wreck has long been familiar to readers, and is immortalized by Cowper's pathetic ballad, but the chief facts may be recapitulated here.

The "Royal George" had long been an object of pride, not only to the navy, but to the English public. She was the oldest first-rate in the service. She carried 108 guns, and it was said had borne more Admirals' flags than any other ship in the British navy. Anson, Boscawen, Rodney, Howe, and other great admirals, had successively commanded her. Aboard this vessel Lord Hawke led the squadron which defeated the French under Conflans, when the "Superbe," of seventy guns, was sunk by her brass cannon, and the "Soleil Royal," of

sixty-four guns, was driven on shore and burnt. She carried the tallest masts and the squarest canvas of any English built man-of-war, and had originally the heaviest metal. Altogether the "Royal George" may have been considered as the embodiment of the naval glory of England then at its height. At the period of her disasterous end she had just returned from a cruise off Spithead, where Lord Howe's fleet of between thirty and forty sail of the line, many frigates, and two or three hundred merchant vessels were riding at anchor. It was on the 28th of August, 1782, as she lay here quietly surrounded by the "Victory," the "Barfleur," the "Ocean," and the "Union," all three deckers, that the carpenter discovered that the pipe which admitted the water to cleanse the ship, was out of repair. As the orifice of this pipe was about three feet below the surface of the water, it was necessary to heel the vessel slightly over, so that the pipe could be raised and examined. This simple operation, which had frequently been performed in the navy with impunity, was the chief cause of the terrible disaster which followed. To accomplish it the guns on the larboard side of the ship were run out of the portholes as far as they could go, and those on the starboard side removed to the middle of the decks. This brought the port-hole sills of the vessel on the lower side nearly even with the water. Unfortunately a lighter, laden with rum, soon afterwards arrived, and placed her cargo aboard on the lower side. This with the additional weight of the men caused the water to enter at the ports, but so gradually that it was long before any one perceived the danger

The carpenter was the first to observe the progress

made by the water. He immediately repaired to the upper deck, and requested the lieutenant of the watch to order the ship to be righted. This officer, however, an obstinate man, made light of the danger. Meanwhile the smiths and braziers had almost completed their work, when a sudden breeze blew upon her raised side, forcing her still further down, while the water began to rush with terrible force into her ports. The lieutenant of the watch now ordered the drum to beat to right the ship—but too late. As the vessel heeled over, guns, shots, and everything moveable rolled with it to the lower side, and accelerated her descent, and the enormous vessel fell on her broadside flat with all her masts in the water. Then was seen a confused multitude of men and women scrambling to the side still left out of the water, and uttering heart-rending lamentation. So sudden was the accident from the time it had become sufficiently alarming to arouse general attention, that scarcely any succour could be rendered even by the multitude of vessels which lay at anchor near. Signals of distress were fired for help from Spithead, but the unfortunate vessel finally sank. Of the twelve hundred persons on board, including two hundred and fifty women and children belonging to the seamen, nearly nine hundred perished. The rest escaped by mounting to the rigging or clinging to floating timber. With those lost was Admiral Kempenfeldt, who at the moment of the occurrence was writing in his cabin, whence his captain had in vain endeavoured to extricate him. Among the numerous affecting episodes of this historical shipwreck was the saving of a little child who was miraculously preserved by holding on to the fleece of a

sheep, which swam in the water, where the child was picked up by a gentleman in a boat. Both the father and mother of the child had perished, and the gentleman who rescued him humanely undertook to provide for him.

The shock of this terrible calamity was long remembered in England; and at many a winter's fireside those who had been saved from the perils of that day, or had been spectators of the scene, must have drawn little children and grown people about them to tell that doleful tale. Meanwhile plans had been submitted to the Admiralty for raising the wreck, which was dangerous to the navigation. An ingenious and enterprising man named Tracey, residing at Portsea, was authorized to undertake the task, which he commenced in 1783. His plan was to pass sling cables round the lower part of the hull of the wreck, making them fast to huge lighters and other vessels, which as the tide rose were expected to raise the wreck. After long and laborious attempts, in which he succeeded in slightly raising the sunken mass, Tracey was finally compelled to abandon the work, having ruined himself by the expense to which he had been put. Twenty-three years later Mr. Ancell, of the Dockyard, Portsmouth, descended on to the wreck in a diving machine, and reported that it had a beautiful appearance, being covered with small weeds "interspersed with shells, star-fish, and a species of the polypus lying on a grey sediment about an eighth of an inch thick." Mr. Ancell also reported that the state of the ship precluded the possibility of its removal either together or in detached parts; but in this, as subsequent events prove, he was mistaken.

In the year 1834, Mr. Dean, an engineer, with the authority of the Government, descended by means of a ladder to the wreck, being attired in an apparatus of his own invention, which has since become better known to the public. His dress was described in the journals of the time as "composed of india-rubber, made perfectly water-tight, having a helmet of metal on his head extending to his shoulders, large enough to allow him to turn his head round at pleasure, having three glass lenses to admit the light, and a tube of the same flexible material on the top to supply air by means of an air-pump, worked by men in attendance above." This ingenious dress has since been successfully employed in numberless undertakings of the kind, and in spite of some fatal accidents, has been proved when carefully used to be comparatively safe. Mr. Dean found the unfortunate vessel a huge mass of old timber, stores, and materials mixed with mud, clay, and sand. In his dress, though he had attached to him nearly ninety pounds weight to make him sink, he easily walked about the ruins of the ship, using his hatchet freely, and remaining down more than an hour each time. In this way he succeeded in recovering a number of valuable brass and iron guns in a high state of preservation, besides a number of interesting articles of less importance.

No further attempts were made to remove any portion of the "Royal George" until 1839, when it occurred to the ingenious mind of Col. Pasley that gunpowder, so commonly applied by miners in blowing up solid rocks as well as in military operations, might be successfully employed for the purpose of breaking up

the wreck, by which some of its valuables might be recovered, while a dangerous obstruction would be removed. Objections were long urged that a partial removal of the wreck might be more damaging to the roadstead than the remains of the vessel in their then state, by scattering portions of her timber; but Col. Pasley having experimented in the blowing up of a small vessel sunk in the Thames, these fears were removed, and in August, 1839, he began his operations. Two divers and two sets of workmen were employed in different lighters moored near enough to be within hail. The divers were attired in Mr. Dean's apparatus. The first experiment proved a failure, owing to an accident in the cylinders and other causes. Other huge cylinders filled with gunpowder were then sunk, and on the 29th of August, the anniversary of the sinking of the "Royal George," five small charges were exploded. The explosions were effected by the fusees invented by the ingenious Beckford, being fired by the wires of the voltaic battery—an entirely new application of that wonderful instrument. On the 23rd of September a large cylinder, charged with 2400 pounds of gunpowder, was lowered and carefully placed by the divers, and all being ready, Col. Pasley directed it to be fired. Instantly, before the eyes of thousands of spectators from Portsmouth and the Isle of Wight, a kind of water spout of immense magnitude was seen to rise into the air, and the surface of the water was found strewed with pieces of the wreck as well as with large fish which had been stunned by the shock. In this and the following year numerous cylinders of a similar kind were sunk and fired, the divers each time reporting successful results, while gradually

the guns and other valuable articles were recovered. The list of some of these is curious. Seven pieces of brass cannon brought up were valued, as old metal, at upwards of £1300. A piece of red sealing-wax, and the handle of a penknife, found near the stern, are supposed to have belonged to the unfortunate Kempenfeldt. Some chinaware in perfect preservation, and several dozen of wine—the contents of which we are told were anything but palateable—are also in the list. Articles of a more mournful interest were also among these curious relics. Of these were the remains of a woman's gipsy hat of the style of 1782, composed of chip, covered with silk, and trimmed with gauze; the crown of this was gone, but in other respects, even to the head lining, it was complete. Some weeks after this hat was brought up, the hoods and collars of two silk cloaks were found—one of woman's size, trimmed with lace, the other (evidently that of a child) without trimming. These cloaks being interwoven, it was thought probable that their wearers, perhaps a mother and daughter, had perished at the same moment in each other arms. With these came torn fragments of clothing, such as arms and breasts of jackets, coats, silk handkerchiefs, shoes, shoe-buckles, skulls, human bones, surgeon's instruments, old quadrants, a pair of black satin breeches, and a large satin waistcoat with flaps, of which the satin was perfect, although the lining was entirely gone. Finally came an interesting relic of the great shipwreck, being one of the identical pipes with the brass work attached to it, in perfect condition, the repairing of which had led to all the disasters of that fatal day.

MR. DIRCKS' OPTICAL ILLUSIONS.

It will, no doubt, be quoted hereafter as an evidence of the practical tendencies of our age, that an ingenious gentleman has lately not only invented a ghost of a far more effective character than any described in the old romances, but has recently actually patented his invention, and rendered it the subject of formal legal proceedings in the Court of Chancery. This gentleman is Mr. Henry Dircks, a civil engineer, and author of a "History of the Search for Perpetual Motion." Like other inventors, Mr. Dircks has been harassed by denials of his claims to originality, and by attempts to prove that his curious spectral illusion was well known to our forefathers; but it is undoubtedly true that, until he first surprised and delighted young folks at a popular institution in London with representations of his shadowy personages, managers of theatrical exhibitions were contented to represent these things by contrivances so rude, that it was difficult for the simplest spectator to feel even a momentary faith in the spectral forms before him.

The secret of this amusing optical illusion, with which so many persons are now familiar, lies in the use of a transparent mirror. Some twenty years since, Mr. Dircks invented what he calls "a plane mirror of unsilvered glass," but finding no practical utility in the contrivance, he soon laid it aside. "It happened," he says in his statement on this subject, published in 1863, "that, within the last two years, I accidentally observed

a solid body in a peculiar situation, by which it was apparently rendered transparent. It was, in short, an effect illustrated by my plain, unsilvered-glass mirror in its principle. I immediately saw that, by means of this combination, the singular appearance could be produced of getting behind a mirror, and communicating with its shadows. Here, then, a means was at once at hand for producing the best possible illustrations of all descriptions of spectral phenomena."

For obtaining the effect, the inventor arranged an oblong chamber into two equal portions, making the separation between the two by means of a sheet of thin glass, having a perfectly true surface. By placing the living actor on a sunken stage below the spectators, and between them and the glass, and, by nicely arranging the angle of light, a complete image of him is thrown forward, apparently as far beyond the glass screen as he is distant from the front of it. The principle may be seen in the reflections of fires and illuminated objects, which are often noticed in the windows of a room by persons within, which reflections always appear to be outside the apartment; but the result of the apparatus described is to give the reflection a marvellous reality, which is only broken when some solid object is passed through the shadowy one, or when the latter, by a turn of the machinery, is made slowly to dissolve into air.

This simple but beautiful discovery in what has been happily termed "natural magic," forms an important addition to our stock of indoor amusements; but, unfortunately, the apparatus required for its effective performance is more costly than that of its popular forerunner, the well-known magic-lantern.

THE DISCOVERER OF WATER-GLASS.

One of the prettiest, as well as one of the most useful of recent discoveries in the arts, is that of water-glass, sometimes called soluble glass, for which we are indebted to the late Dr. Johann Fuchs, formerly Professor of Mineralogy in the University of Munich. Fuchs was a man of simple studious habits, who prosecuted his researches with patient industry in spite of the indifference, and even of the injustice, which he met with from his contemporaries. It was in the year 1825 that he announced in "Kastner's Archio," a well known German work, the principle of this discovery, and pointed out some of the important uses to which it might be applied; but scientific men of the day paid little attention to his ideas. In a pathetic narrative of these circumstances, Fuchs tells us that he was even told that his discovery differed in no respect from the well known liquor silicum, or water of flints, adding, "Experiments were made but abandoned as soon as they were found not to lead to satisfactory results, undertaken as they were without the necessary knowledge or understanding. Greater expectations were raised than could in the nature of things be satisfied, and failure, owing perhaps to faulty manipulation, frequently caused the process to be abandoned before it had been put to a fair test."

Fuchs had attained an advanced age before he was fortunate enough to find the utility of his discovery generally acknowledged. Shortly before his death,

which took place in 1856, he published a pamphlet, in which he minutely described the principles as well as many of the applications of water-glass, "in order," as he said, "to render the experience gained by myself and others available for further investigations." In this pamphlet—notwithstanding the ungrateful treatment he had received from the world—Fuchs generously made public all that was necessary to be known for giving utility to his discoveries, while giving expression, though with no bitterness, to the disappointment which he felt at the cold reception which had been accorded to him. But he acknowledges with satisfaction, that "a few years have changed much, and it has been thought since that water-glass, after all, did not belong to the class of superfluous things, but that few other bodies were capable of being put to so many and such various uses."

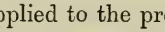
This remark of the worthy inventor has been fully justified by the progress which the use of water-glass has made of late years; but it is probable that an infinite variety of applications have yet to be discovered. It has been used in painting on glass. Wood and other substances are rendered less combustible by it. One of the earliest of the practical adopters of the discovery was a glass-maker in Germany, who, it is stated, varnished the wooden roof-blocks of an entire village with water-glass upwards of thirty years since to protect them from fire. Theatrical dresses and scenes may also be rendered more safe by these means. Old paintings on panels, on being protected by water-glass, have been found to stand intense heat or numerous washings without injury. An indelible ink has been made by grinding

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carbon with it. In calico printing it has been found of the highest utility in fixing the colours, but perhaps the best known of its applications is that of protecting building stone from decay, which has been recently tried on the Cathedral of Notre Dame, the new Houses of Parliament at Westminster, and other buildings.

While Dr. Fuchs and another ingenious German, Professor Kuhlmann, were successfully pursuing their researches in this field, our own countryman, Mr. F. Ransome, of Ipswich, had by independent investigations discovered a method of dissolving pounded flints in a solution of caustic alkali, which is similar in its results to Dr. Fuchs' discovery. Mr. Ransome's water-glass has been successfully applied to the preservation of the surface of stone-work in a great number of public buildings.

MR. GOLDSCHMIDT, THE PLANET-FINDER.



The inexhaustible nature of scientific discovery could not be better exemplified than by the fact that, even after the researches of Herschel, Piazzi, Leverrier, Adams, and others, it was reserved for an amateur astronomer to discover eleven minor planets, for which important contribution to our knowledge of the heavenly bodies, the Royal Astronomical Society awarded in 1861 their gold medal. This was Mr. Hermann Goldschmidt, a young Frenchman. The Rev. R. Main, the president of that Society, in a recent address, has given the following

interesting sketch of the astronomical labours of Goldschmidt. "Lutetia," says Mr. Main, "the first planet discovered by him, is estimated at the 9—10 magnitude, a size which we probably should not have thought of looking for with any object-glass of less than four or five inches, and this he discovered with a telescope of hardly two inches aperture—such a one, in fact, as you see frequently used at watering-places for looking at ships and other objects. This telescope was one of which the young astronomer might well be proud. This, or a smaller one of one and a half inches aperture which it replaced, was purchased with the proceeds of the sale of a copy of a portrait of Galileo, which he had painted at Florence. Never, perhaps, were such great results accomplished by such small means; and if this be, as is generally supposed, an attribute of genius, Mr. Goldschmidt may fairly claim the admiration which is due to it. A telescope of two inches aperture placed in the window of a garret forming the sleeping apartment of the astronomer, is made, by judicious handling and severe scrutiny of the Berlin star-maps, to discover one of a class of objects which it taxes to the utmost the astronomers of Greenwich to observe, when it is found with the great transit circle. By the practice of a most rigid economy, Mr. Goldschmidt became able to purchase another telescope, an improvement on the preceding, having an aperture of two and a half inches, and even with such an apparently inadequate instrument he discovered four more planets. Subsequently, obtaining a telescope of four inches aperture, he discovered eight other planets. None of his telescopes were mounted equatorially, but in the greater number

of instances they were pointed out of a window which did not command the whole of the sky.

It was by a singular accident during Goldschmidt's search for the planet Daphne, that he was led to the discovery of another new planet. Soon after his discovery of Daphne, a long continuance of unfavourable weather compelled him to suspend his observations before he had been able to complete his calculation of its orbit. The new planet was therefore lost, and its discoverer compelled to commence his search for it again. After more than twelve months of patient labour, he succeeded, as he believed, in this object; but in this belief he was subsequently proved to have been mistaken. In fact, the planet which he believed to be the long-lost Daphne was not Daphne at all; but another planet hitherto altogether unknown to astronomers. This planet, in reference to this original error of its discoverer, received the name of Pseudo-Daphne. The rapidity with which new planets have recently been discovered is astonishing. At the commencement of the present century only seven were known to astronomers, six of which had been known to the ancients. At present the planets discovered number no less than eighty.

MICROSCOPIC WRITING AND ENGRAVING.

Among the Assyrians the common mode of keeping records of national and historical events was by stamping the words upon bricks, tiles, or cylinders of clay, baked

after the inscription was impressed. Mr. Layard, in the course of his excavations at Nineveh, found many specimens of these records, most of which were written in such minute characters that the aid of a microscope was required to ascertain their forms. How letters so small were produced at this period is not known, but the means employed for reading them was probably the common magnifying lens. One such instrument, rudely made of rock crystal, was found by Mr. Layard among the ruins of the palace of Nimroud.

It is interesting to contrast these ancient relics with the wonderful microscopic writing, printing, and engraving of our days, for which we are indebted to Mr. Peters' microscopic pentagraph, and to the similar instrument of Mr. Webb, which he designates the micrograph—a modification of Mr. Peters' invention. The results of the employment of these instruments are so marvellous, that few who have not examined specimens of their work could conceive their possibility. In a space, looking to the eye like a minute dot, being in fact only the 356,000th part of a square inch, Mr. Peters has succeeded in writing the whole of the Lord's Prayer in a character which, under the microscope, becomes beautifully clear and legible. The Lord's Prayer, ending with "Deliver us from evil," contains exactly 223 letters; and hence it has been calculated that the entire Bible might in this way be written in less than the twenty-second part of a square inch. In using the machine, the operator first writes with a pencil attached to one end of a long lever; and the marks thus made are infinitesimally reduced in corresponding motions, by which a glass plate is moved over a minute diamond point.

This beautiful illustration of microscopic art has also been successfully applied to the delicate process of engraving and printing from copper plates. Among the chief difficulties of the inventors was that of finding an ink which could deliver impressions from such exceedingly minute engraved lines on copper. Some of the letters engraved are stated to measure only the half-millionth part of an inch. Numerous applications of the art of microscopic writing have been devised. Among the most popular of these is perhaps the invisible address card. A Lilliputian glazed card is presented, without the slightest trace to the eye of any inscription. A strong pocket lens, of infinitely greater power than that rude instrument found by Mr. Layard among the ruins of the Assyrian palace, shows when applied to such a card, only two faint and delicate lines impossible to be deciphered; but the microscope at once brings out a name and address in elegantly-formed letters, perfectly distinct.

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